HYDROCARBON PROCESSING &
Petroleum
REFINER

JULY 1961

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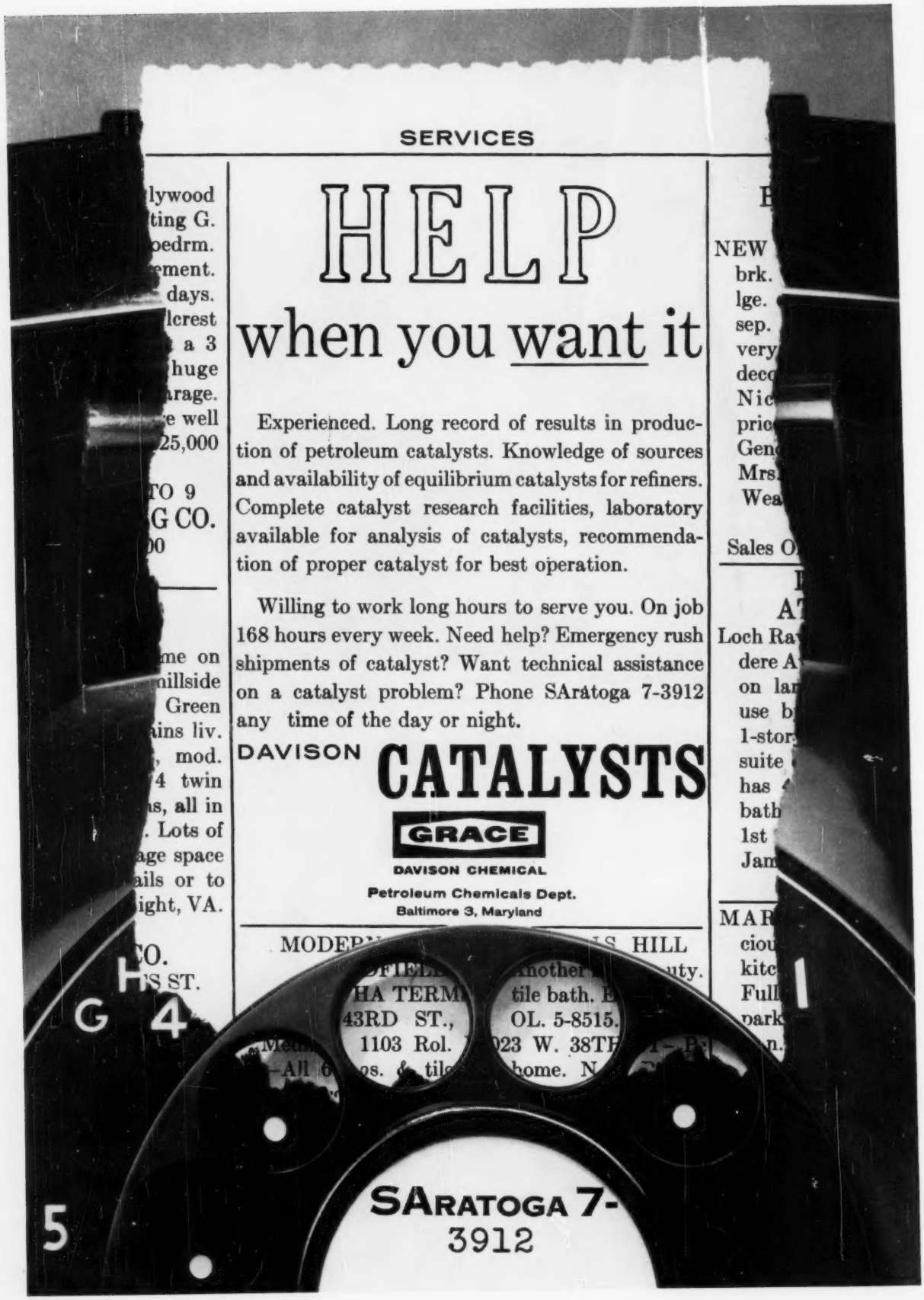
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HYDROCARBON PROCESSING & Petroleum REFINER

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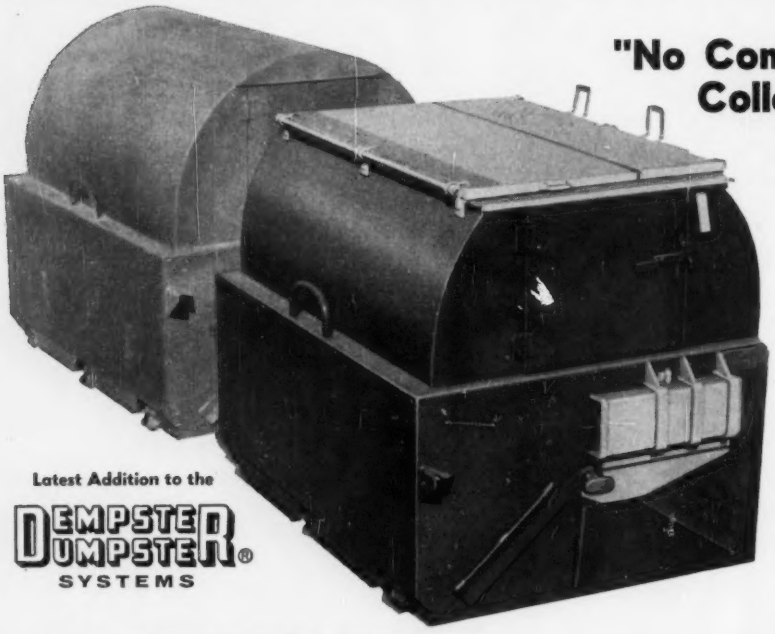
New SUPER DUMPMASTER Handles Converted DUMPSTER Containers...Beats Long-Haul Problem



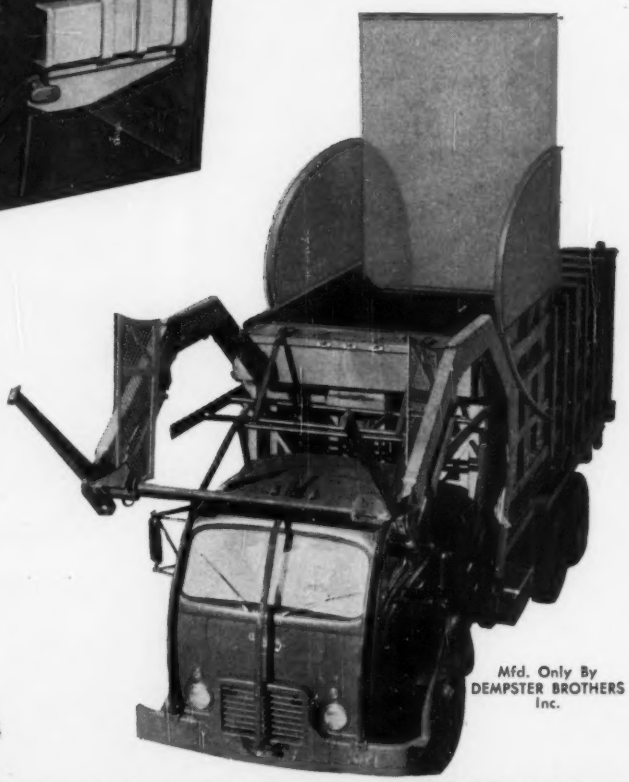
Latest Addition to the
DEMPSTER DUMPSTER® SYSTEMS

"No Container Haul System" Collects Refuse on Spot

If longer trips to disposal areas have raised your operating costs, a small investment in conversion kits protects large investments in DUMPSTER containers. The Super DUMPMASTER handles converted DUMPSTER containers up to 12 cu. yd. and all DUMPMASTER containers one thru 12 cu. yd.

Owners of DEMPSTER-DUMPSTER Systems who now face long haul problems due to movement of disposal areas may now convert from their present "container haul" system to the new SUPER DUMPMASTER "no-container-haul" system without abandoning their investment in DUMPSTER Containers.

The SUPER DUMPMASTER makes its rounds to each converted container, mechanically empties the contents into its 30 cu. yd. packer body and compacts the material to a fraction of its former volume with the 85,000 lb. force of its packer plate. Rather than haul each container to the disposal area, the SUPER DUMPMASTER carries the contents of many containers on each trip, cutting collection costs drastically.



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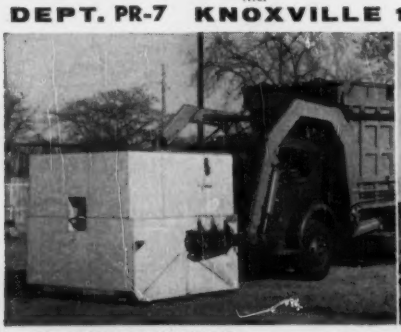

The SUPER DUMPMASTER engages container.

Clearance arms carry it toward hopper opening.

Container is rotated, emptying contents into the compaction body.

A Quick Look at This Issue

☐ **How to Estimate Plant General Costs . . .** Here is the useful information on preliminary evaluations and completed plants you have been waiting for, so turn now to **Page 123.**

☐ **How to Distribute Manufacturing Costs . . .** This article shows how Allied determines, assigns and distributes indirect and direct manufacturing costs. For facts on how you can solve similar problems, see **Page 125.**

☐ **Estimate Forced-Draft Fan Costs . . .** These data for pricing 30,000 to 150,000-scfm heavy duty fans are a real shortcut when preparing budget estimates. For the details, see **Page 129.**

☐ **How to Estimate Operating Costs . . .** This item gives a method which is useful in making preliminary economic evaluations. Correlations are shown for variations in investment and operating capacity estimates. To use this for your plant cost studies, turn to **Page 133.**

☐ **Design Tips for Refinery Tank Farms . . .** Three variables control the design of refinery storage tanks, pumps and miscellaneous items: (1) crude yields, (2) sales estimate and (3) refinery production forecast. To see how these are predicted and two detailed examples on the design of storage tanks and accessories, turn to **Page 140.**

☐ **Acrylonitrile—Petrochemical Prodigy . . .** This article brings you up to date on manufacturing processes, chemical reactions and end-use markets. For the complete story, turn to **Page 145.**

☐ **ASME Head Design Simplified Using Influence Coefficients . . .** Recent computer investigations show that empirical code formulas predict low stresses in standard ASME heads. Galletly worked out a way to improve stress predictions using edge influence coefficients. This work is simplified by charts that reduce calculations from as long as a week to a matter of hours. For the simplified method, turn to **Page 155.**

☐ **Equipment Cost Data File (Part 4) . . .** To get the latest cost data on hemi-spheroids and spheroids, see **Page 163.**

☐ **Reports for Maintenance Cost Control . . .** Don't worry about what you need to tell the computer, develop the report you want and get a data-processing programer to solve the problem. This article reports developments by Du Pont for better maintenance cost control. For complete details turn to **Page 165.**

☐ **How Temperature Affects Reaction K's . . .** Here is a nomogram for determining the equilibrium constants for pyrolysis of light hydrocarbons. For details, turn to **Page 168.**

☐ **Measure Boiling Points Continuously . . .** Here's what you can expect from continuous on-stream analyzers designed to measure boiling points. They are accurate enough to gain operator confidence and give more consistent results than laboratory apparatus. See the details, **Page 169.**

☐ **Automation Today (Part 26) . . .** Computers are often the best and sometimes the only way to implement proper control of a process. To see whether analog or digital computers can handle your process control problem, turn to **Page 175.**

☐ **Add Ethylene Production for Profit . . .** Using an existing 50,000-bpd refinery, this article gives details on economics, operating costs, manufacturing costs and advantages of this type of integration. See **Page 179.**

☐ **Remote Control Cuts Tank Farm Costs . . .** The remotely controlled functions at Humble's Baytown refinery tank farm are: tank gaging, pump and valve motor control, pump discharge pressure indication, alarm, and override tank level controllers. Equipment selected, why it was selected, installation tips and maintenance experience are given, starting on **Page 183.**

☐ **Reboiler Selection Simplified . . .** Arbitrary selection of reboiler types and feed systems are too often made without considering other process and economic possibilities. Here is an analysis of six reboiler feed systems together with calculation check points for the process engineer. For details, turn to **Page 189.**

☐ **Judging People by Physique (Part 1) . . .** The technique of evaluating people by what we "see" has existed longer than any other, but has been side-stepped as "unscientific." Here, a noted artist and management consultant delves into a controversial subject on which some segments of science are now taking a less negative stand. See **Page 199.**

☐ **A Court's-Eye-View of the Refinery 'Nuisance' . . .** A comparison of recent and old court decisions reveals an "easing up" of the so-called "nuisance" law as it applies to refineries and other processing plants. For interesting discussions of one of the industry's oldest problems, turn to **Page 205.**

Improve your Engineering I.Q.*

* INCOME QUOTIENT

Buyer-Seller "Alliance" Important To Engineers; Orders Are Born of Confidence

It is oftentimes surprising to the engineer that in the course of his career, if it is to be a rewarding one, he will be required to develop talents of both selling and buying. To put it simply: *either you have sold or you have been sold every time you talk to someone.* If you haven't closed your mind, you will often be sold. If you are competent to do so, you will just as often sell someone else.

Selling and buying processing equipment is a highly developed field, but essentially it consists of buying and selling ideas. As you advance into supervisory, management and executive functions, you will be called on to exhibit greater buyer-seller abilities.

Most buying in industry involves from three to six individuals. Although the purchasing agent will be a key factor in all purchasing, almost all purchases in technical fields require the technical assistance of someone outside the purchasing department.

An industrial buyer, whether he is a purchasing agent or an engineer, is *human*, and is responsive to the same human values that you are when you buy a car or a suit of clothes. The industrial purchaser, though, is keenly aware of the plant and organization for which he buys. He is conversant with the product needed, and with its ultimate use.

The purchaser's objective is to procure the right equipment or material, of the right quality, in the right quantity, at the right time, from the right source, and at the right price. In accomplishing this he actually becomes a "salesman-selling-a-salesman."

In modern business the purchasing department should be a profit-making department. A four per cent savings in purchase costs, for instance, might be equal in profits to a 20 per cent increase in sales volume. Considering that the average industrial firm spends about 50 to 60 cents of each sales dollar for purchases, purchasing savings can easily represent the margin of profit.

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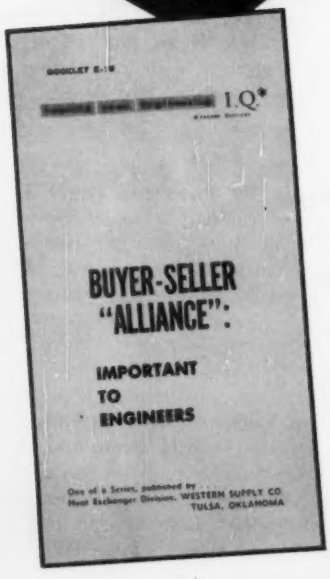

The foregoing paragraphs are taken from one of Western's "professional development" booklets, and reflect our own philosophy on the subject.

Understanding both sides of the coin — the problems of the buyer as well as the responsibilities of the seller —has long been required of all Western sales and engineering personnel. It has contributed greatly to the compatible relationships Western enjoys throughout the petroleum and chemical industries.

Your invitation to discuss heat exchanger problems with your purchasing and engineering departments would be welcome . . . as will your request for your copy of "Buyer-Seller 'Alliance' Important to Engineers."

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PIPE LINE INDUSTRY and The PIPE LINE CATALOG for the oil and gas pipe line industry.

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"The Very Tops"

HP-PR's series and Special Reports, generally, are of such permanent value that a great number of them have been selected by GPC for hard-back books. Three such books have just been published and three more are in production. In the first group are—

- Polyolefin Resin Processes, an expanded version of Marshall Sittig's November Special Report. (Circle E23 on Readers' Service card opposite Page 330.)
- Operator's Handbook, an expansion of the popular series dealing with gasoline plants and concluded last December. Prepared by Tenneco Oil Co. engineering staff. Circle E24.
- Group Dynamics—Key to Decision Making, based on a popular Management series recently concluded. Circle E25.

(The "Circle E numbers" injunction is one way of getting your volume which will be mailed promptly along with the bill.)

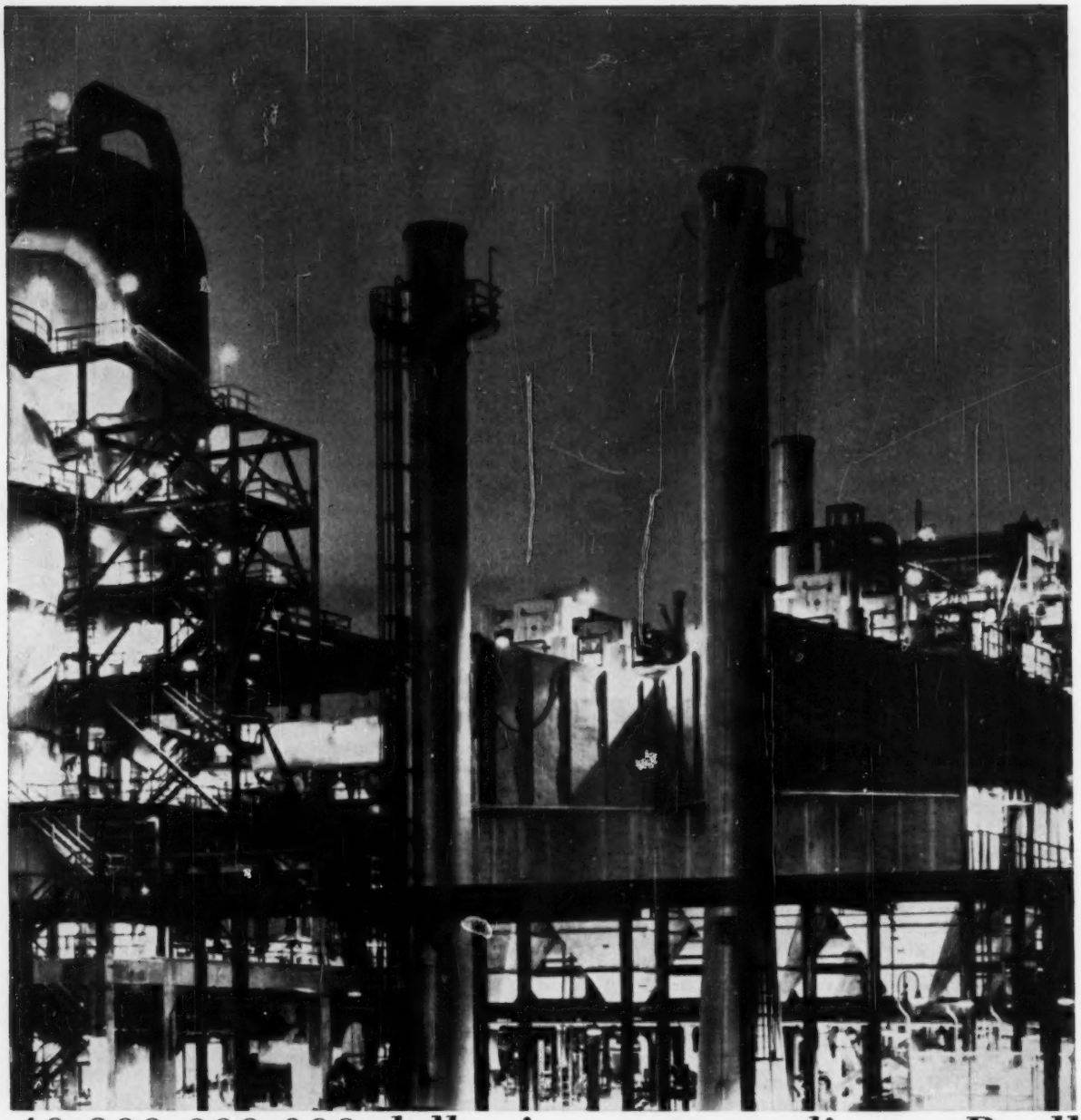
Or you may want to reserve copies of the three other volumes that our Book Department now has in the works. These are listed below and copies will be reserved for you if you will pencil a short no. to that effect on the Readers' Service card and drop it in the mail. The coming-uppers are—

- Applied Hydrocarbon Thermodynamics by Wayne Edmister based on the popular and useful series just completed.
- Automation in the Chemical and Petroleum Processing Industries from Dr. Ted Williams' extremely informative series, "Automation Today."
- How to Plan to Retire by Forrest E. Gilmore, the June Special Report that has brought such widespread reader reaction.

Besides offering these books, this blurb would remind readers near and far of something they already know, viz., HP-PR gives you the very tops in technical reading each month.

NOW AND THEN these pages contain a plug for that versatile product of our industry, asphalt. On several occasions over the past few years, for example, we have tried to tell the segment of the world who reads HP-PR that asphalt, properly applied, makes a mighty fine highway surface. On Page 15 of this issue there is another such presentation figures for which we obtained from The Asphalt Institute whose director of publications, Glynn Harvey, was asked to confirm the accuracy of the numbers used. It's a remark in his covering letter that we want to cite here: "We certainly appreciate your special interest in telling the asphalt story. Sometimes we wonder if we're getting through to the parent petroleum industry, and any help we can get from you fellows who reach those people directly is most welcome."

Sad commentary there! Petroleum industry people should never overlook an opportunity to do all in their power to promote the use of asphalt as well as other petroleum products. In that way our industry becomes more prosperous.



40,000,000,000 dollar investment relies on Buell

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From the editors ...

Quick Look at HPI

HYDROCARBON RESEARCH INC. UNDER FIRE as government suspends general license privileges for export of U.S.-origin techincal data to Sino-Soviet bloc and Cuba. This issue: Did company and affiliates use unpublished U.S.-origin technical data in connection with design and construction contract to build refinery-petrochemical plant in Rumania? Contract was made in 1959 and plant is near completion. Company denies charge.

USE OF METRIC SYSTEM for U.S. standards of weights and measures is goal of bill introduced in Congress by Oregon's Senator Neuberger. Proposal would authorize Commerce Department to conduct study and make a report within three years. Meanwhile, similar bill in House is hung in committee.

AUTOMATION JOB PROBLEMS have attention of Administration, as President announces proposed program to train or retrain "several hundred thousand workers over 4-year-period . . . to replace skills made obsolete by automation." Labor Department's recommendations: (1) retrain and relocate workers hit by automation, (2) provide advance warning for automation layoffs, (3) train workers in advance of layoffs to operate new machines, (4) set up regional clearing houses to spread information on automation.

KEROSINE HITS COMEBACK TRAIL via everything from jet aircraft to Florida smudge pots, buses, and tobacco-curing barns. Marketers predict by 1965 jets will gobble more than double present 100,000-bpd capacity. Nation-wide kerosine consumption last year was more than 400,000 bpd.

IMPORT-CONTROL INVESTIGATION on way as House Small Business Committee sights in on alleged inequities. Program, set up to maintain vigorous, competitive industry, appears to be weakening oil business and fostering monopoly control, says Committee Chairman Wright Patman (D.-Tex.). The consensus: Small refiners who can't use foreign oil are passing import quotas to majors, which have facilities to process imported oil.

TETRAETHYL LEAD CONTENT in gasoline may go from present 3 cc to 4 cc per gallon, after Public Health Service studies current lead levels in air and human body. PHS special committee says increase would probably not pose additional air pollution problem. But committee leaves door open while awaiting outcome of one-year $100,000 study.

GOVERNMENT OWNERSHIP OF PATENTS controversy still rages in Congress, but rigid Federal patent policy seems unlikely to emerge. Says Senator McClellan (D.-Ark.): "problem of patent ownership on inventions stemming from government R & D contracts is too complicated to warrant rigid policy of government control." The big problem: How to write a law that's equitable to all concerned. (For key issues in patent question, see May HYDROCARBON PROCESSING & PETROLEUM REFINER, page 13).

PLANNING ON WIDER USE OF COMPUTERS? Keep in mind that equipment costs can usually be accurately forecast. Not so with programing. This item can

cost much more than you expect, according to recent IBM survey of refiners using computers. Result: More emphasis on programing techniques.

A SQUINT AT THE FUTURE of synthetic natural rubber shows new stereospecific variety (polyisoprene and polybutadiene) will likely hit 370,000 tons a year by 1965, while overseas capacity will soar even more to 500,000 tons . . . In plastics, look for output to hit 1.6 billion pounds by 1975, with high-density polyethylene alone jumping from 170 to 233 million pounds this year.

PANNING THE PROCESS AND PRODUCT SCENE you'll see Enjay up with butyl rubber in latex form. It's a chemically stable emulsion of butyl rubber in water containing 55% solids . . . Sohio develops new device to detect abnormal gasoline-engine combustion—a vibration pick-up unit that mounts on lower engine block near front main bearing . . . New technique of "interfacial polycondensation" may extend polymer uses. Method lets thin layers of polymers form on fibers and sheet metals at room temperature . . . New extraction process with advantages in high-purity isobutylene production or removal of isobutylene from other olefins developed by Compagnie Francaise de Raffinage. It's being licensed by Badger Manufacturing.

Refrigeration steps aside as 55-60% of fluorinated hydrocarbons goes into aerosol products . . . Institute Francaise du Petrole up with new low-cost isoprene production process that may give polyisoprene lead on other kinds of synthetic rubber . . . Pan American Petroleum producing higher-molecular-weight carboxylic acids by adding low-molecular carboxylic acids to primary olefins.

QUICK LOOK AROUND THE NATION finds Bureau of Mines planning atomic research facility for Albany, Ore., to determine effects of gamma radiation on physical and chemical properties of petroleum, coal and other substances . . . Du Pont's 12-year anti-trust fight with Justice Department ends with government order to sell all General Motors stock within 10 years . . . Bureau of Mines helium program gets shot in arm as Senate authorizes purchase of $60 million worth of helium a year . . . National Society of Professional Engineers tells House Labor Subcommittee that present denial of separate decertification election from mixed unit by professional employes violates Taft-Hartley Act.

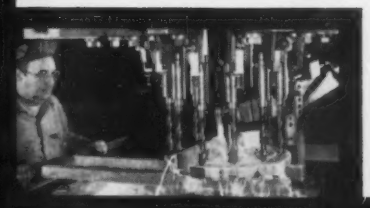
WPRA and NPA officially merge to become National Petroleum Refiners Association . . . Industry views with alarm Administration's plans to tax undistributed profits of foreign subsidiaries of U.S. companies. The consensus: It will stunt growth and new investment here and abroad . . . Fines up to $50,000 assessed against 11 of 12 oil firms convicted of price fixing in South Bend, Ind., case. Gulf Oil was acquitted . . . Contrary to published stories and rumor, no merger planned by LPGA and National LPG Council, says LPGA prexy E. O. N. Williams, but organizations are working "toward greater unity" . . . NGAA in process of changing name to National Gas Processor's Association.

FOR MORE NEWS AND TRENDS on the HPI's latest developments in technology, government affairs, and general-interest news, don't miss the new "What's Happening" beginning on page 39.

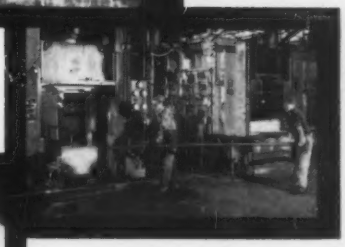
The Source for Better Service . . . a Better Product

B&W's New Fittings Plant is in FULL OPERATION

One of the mill stock bays.



Machining a B&W flange.



Forging a tee.

Packing fittings for shipment.

Machining a 24″ elbow

The paint line.

The transfer of B&W's welding fittings operations from Milwaukee to Beaver Falls is now complete. In full operation is the newest, most modern source for welding fittings and flanges in the industry. In full operation is a welding fittings plant that is integrated with B&W's facilities for steel and tube-making.

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- You can get a complete line of welding fittings and flanges, quality controlled at every step of the production process from melt to the finished product.
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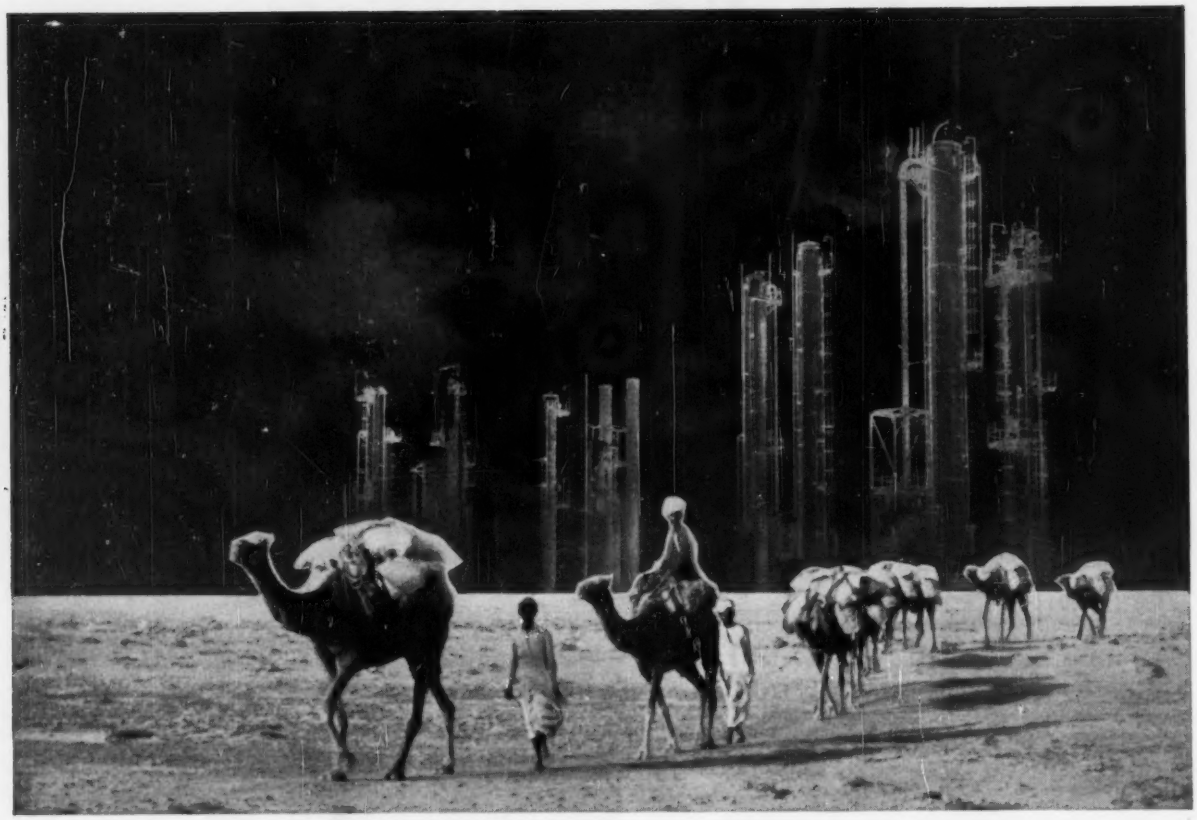

PAKISTAN'S FIRST OIL REFINERY NOW BEING BUILT BY KELLOGG

for British-Dutch-American consortium

Construction activities are well under way on Pakistan's first refinery, near Karachi. Simultaneously, details of procurement—a world-wide operation—are being coordinated in Kellogg offices. Completion of the project is scheduled for the latter part of 1962.

The Kellogg organization will be completely responsible for this 35,000 BPD refinery to Pakistan Refinery Limited. The Burmah Oil Company, Caltex, Shell, Stanvac, together with Pakistani interests, all participate in Pakistan Refinery Limited. Technical coordinator for the consortium is Bataafse Internationale Petroleum Maatschappij.

Important considerations in the selection of the Kellogg organization were cost, speed, ease of maintenance, and the proved ability to undertake and coordinate every phase of engineering, procurement, and construction. Kellogg's contract assures the minimum initial investment and operating costs consistent with good refinery practice and proper safety standards.

For companies considering oil refining or petrochemical manufacturing facilities overseas, Kellogg's international organization offers the optimum return on investments and the soundest kind of economic aid to friendly nations.

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Speak Up for Your Industry!

William F. Kenney, Chairman, Committee on Public Affairs, American Petroleum Institute

PUBLIC RELATIONS problems have haunted the oil industry for almost the entire 100 years of its history. All of us recognize—or should—that these problems must be met as they arise and must be solved as completely and promptly as possible. We should also recognize that oil's public relations problems are two-fold—the kind of problem that can best be handled by individual companies, speaking for themselves, and, secondly, the kind of problem that affects the whole industry. The latter type is susceptible to some kind of joint attack.

A Case in Point. A good example of the kind of problem we can attack jointly is one which marked the industry's advent into the public and governmental relations field—the gasoline tax. In the early 30's, alarmed at the rapid proliferation and unsystematic basis of gasoline taxation, the industry set up the old American Petroleum Industries Committee. It was to collect information and provide an economic and legislative reference service for interested groups of oilmen operating at the state level.

Later, in the years following World War II all of us basked in the warm glow of public approval—a result of the oil industry's tremendous job during the war—steps were taken to continue this pleasant state of affairs, instead of reverting to the atmosphere of the 30's when oil was under constant attack in much of the press, in legislative halls, and in the courts.

Role of the OIC. A public relations arm of API, known as the Oil Information Committee, was set up and it did a very good job of informing the public. It did especially well in two areas in which opinion surveys had disclosed widespread misunderstanding: the degree of competition in the industry and the scope of its product improvement.

Although both APIC and OIC were successful within their defined fields, the feeling began to grow that the public relations cause could better be served by combining these two organizations into one unit. Result: the marriage of the two organizations in 1958 into the present Committee on Public Affairs. The CPA tries to assist and guide the API's efforts in the fields of governmental affairs and public relations.

Only A Tool. The results of this union have been heartening to all of us who had worked closely with either the old APIC or OIC. But remember, the CPA is only a tool to help oilmen with their public affairs. Like any kind of tool, it can not do the job alone. It takes hard work and sustained efforts by all of us in the industry to help such an organization do its job. Solving the industry's public affairs problems is not a spectator sport. Only by enlisting literally thousands of willing participants throughout the oil business can we hope to succeed.

I labor this point a little because I think there is a natural tendency on the part of people in oil or any other industry to sit back and relax once an organization has been set up and a budget approved. We then bask in the comfortable assurance that somehow everything will be taken care of. Any trade association, even one with a substantial staff like API, can only *help* to provide coordination and tools to do the job. It cannot be expected to carry out on its own the enormous task of handling the public affairs for an industry of two million people.

Furthermore there are some areas from which this organization is automatically excluded—either because there is disagreement on the subject within the industry's own ranks (the matter of imports, for instance) or because the answers must come from individual companies and not from a trade association (prices and pricing policies are an example).

Value of Joint Efforts. On the other hand, in certain fields of activity an organization that represents many companies can be much more effective than any of those companies acting alone. Take the CPA school program, which starts with the advantage of being free from any commercial tie. Educational material on the oil industry and petroleum sciences is carefully designed to be useful in the classroom and to avoid even a hint of propaganda. It is presented to the schools by local oilmen. Their enthusiasm for this activity helps to explain why some 29,764 secondary schools—more than 70 percent of the country's total —are now participating in this CPA-sponsored endeavor.

In the collection and dissemination of over-all industry facts and statistics, an association obviously has superior qualifications. Here again the CPA fills a real need. One example is publication of "Petroleum Facts and Figures," the only oil industry-wide statis-

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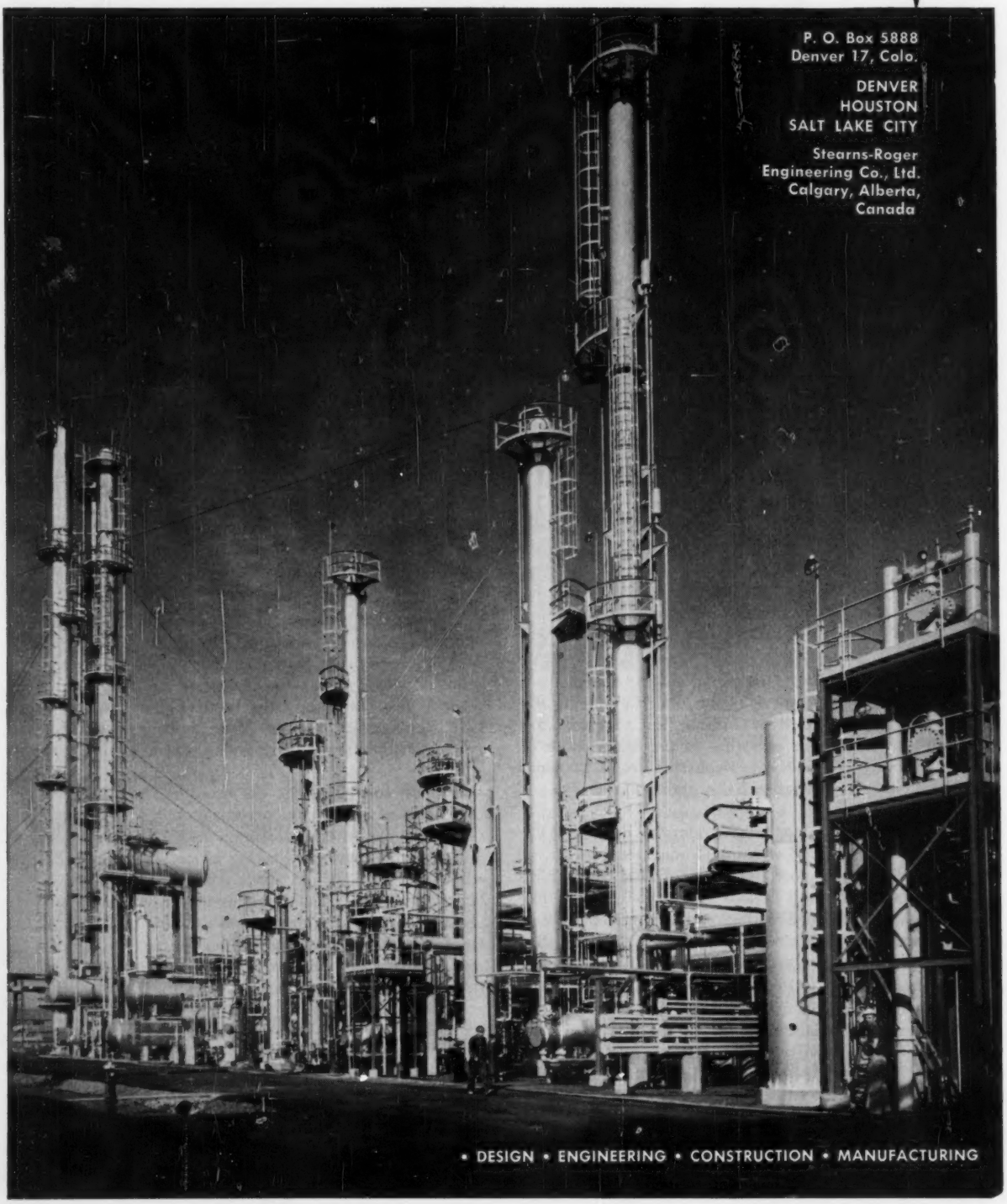


tical compilation of its kind.

The CPA film program also opens many doors and minds to facts about the industry, presented in the most popular form. Besides being shown frequently on television, these films are presented to assembled audiences by many organizations. They reached five million viewers in auditoriums up and down the land during 1960 alone.

For those influential individuals known as "thought-leaders" the CPA has two publications—the newspaper format bi-monthly "Oil Facts" and the quarterly magazine "Petroleum Today." Both provide the kind of information that leads to better public appreciation of the job the oil business is doing.

Informing Employes. An activity that the CPA emphasizes particularly is the employe information program. This contributes to the vital effort to keep oil personnel informed on significant issues of concern to the industry. A quarterly publication—"Oil Features for Editors"—and separate packets of material containing everything from sample posters to illustrated talks have dealt with a number of subjects to date. Examples: the cost-price squeeze, percentage depletion, gasoline taxation, gasoline prices and what is being done to combat air pollution. Besides making prepared material available to the companies, the employe information program tries to stimulate ideas for more effective communication with all men and women in the industry.

These are only a few examples of a broad program designed both to spread the facts and to correct misunderstandings and misstatements about the oil business.

I repeat—the organization is a tool—not a magic wand to be waved in the hope that all the industry's public relations and government relations problems will vanish in an instant. But a promising start has been made, and with the continued support of the whole industry—including a realistic appreciation of the limitations of any joint effort—I confidently expect to see the CPA do an even better job in the years ahead.

Know What's Back of You?

IT'S NOT A BAD IDEA now and then to remind those of us in the petroleum industry that it takes more investment to keep us in our going job than just the cost of a desk, chair and dictating machine. Or the tools that an individual craftsman might be called upon to use in performing his duties out in the plant.

Shell Oil Company recently has announced a figure that might be something of a shock to the complacent souls who are inclined to shrug their shoulders in a "What of it?" sort of way when talk with their fellows turns—if it ever does—to the investment required to support a job.

Because Shell comes up with the figure of $88,000 for each employe! And we feel sure that this is not out of line with the same statistic from other companies of the industry.

Without such an investment, we need not be reminded, there would be no jobs for literally thousands of workers. And, as Shell points out, "effective use of company resources (by employes) is especially important now in view of the cost squeeze affecting the oil and chemical industries generally."

Asphalt Mileage On the Increase

ASPHALT'S VALUE as a road building material and its merits as compared with concrete are confirmed by the recent Stanford Research Institute study. So we will grasp the opportunity to set down some thoughts on the topic, long a favorite of this editor.

The study, prepared for the American Petroleum Institute, deals mainly with cost, and shows that asphalt pavement on main-line highways holds substantial economic advantage over concrete. Twenty-five hundred highway projects in 21 states and 13 toll roads formed the basis for the research project which revealed that asphalt pavement not only costs less to build but has lower over-all annual cost for a 40-period. Savings up to $1 billion would be effected if asphalt were used wherever possible for remaining segments of the Interstate highway program, it was declared.

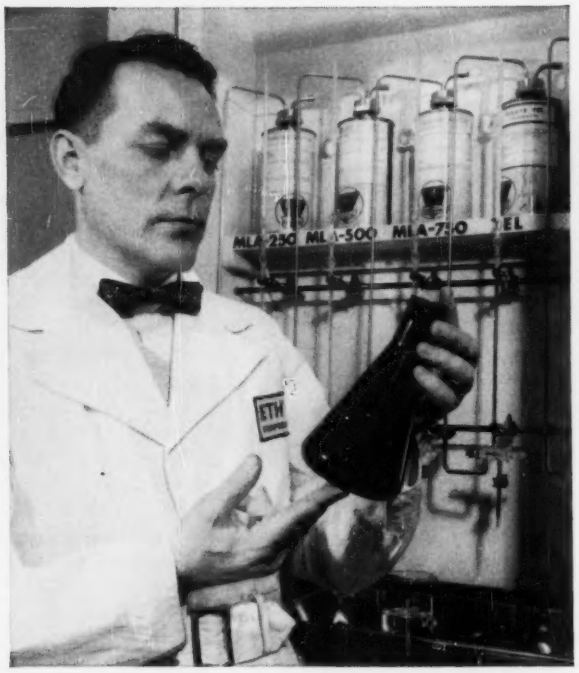
Doubtless the specifics will be studied closely by engineers and other government people responsible for the huge Interstate system. And for the thousands of other highway projects that are underway throughout this and other lands. Money isn't so plentiful—even though some bureaucrats are trying their best to disabuse our mind of that thought—that we can shut our eyes to savings of such proportions.

Use of asphalt for roadbuilding has nearly doubled since the close of World War II, according to the Asphalt Institute. In 1959 asphalt paving totaled 478,455 miles compared with 242,248 miles in 1954. Meanwhile existing mileage of Portland cement concrete surface had declined since its 1942 peak of 95,740 miles. By 1959 this had dropped to 66,677 miles even though 25,000 miles of new concrete pavement had been constructed during that period.

The Institute points out that recently "the great performance records of asphalt pavements using an asphalt-concrete base has touched off a fresh wave of enthusiasm for this type of paving. It's called 'deep-strength' asphalt pavement. We have borrowed from the design experience on some of the notably successful turnpikes to develop this extra heavy-duty pavement which is the logical answer to the challenge of increasingly heavier wheel and traffic loads on our over-burdened pavements."

The oil industry, of course, must continue to do all in its power to keep roadbuilders and roadbuilding agencies "wised up" in the use of asphalt for highway surfacing.

SATISFY MORE CUSTOMERS AT NO EXTRA



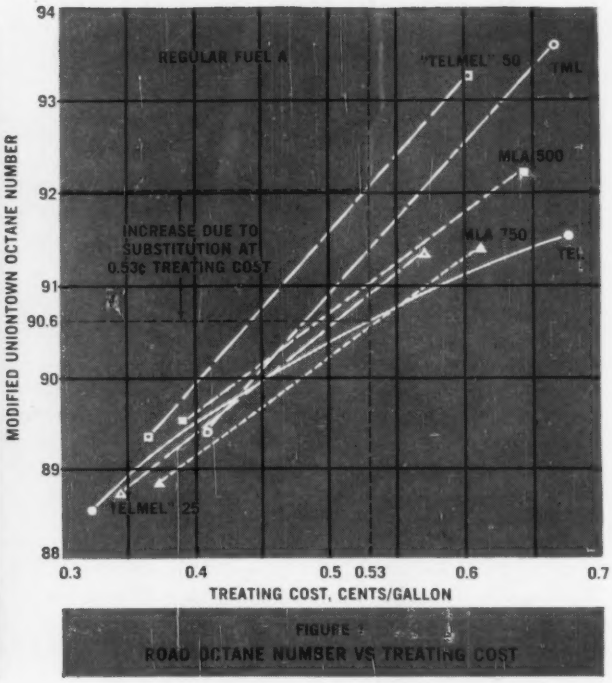


FIGURE 1
ROAD OCTANE NUMBER VS TREATING COST

NEW STRIDES IN antiknock research have made more types of lead alkyls available today than ever before. Now, by using the *right amount* of the *right additive*, you have the means to market a better performing gasoline . . . at no increase in cost. But tailoring an antiknock to a particular fuel can be a complex task—a vital problem Ethyl helps refiners solve every day.

Recently, Ethyl presented a paper at WPRA which gave typical refining antiknock selection cases. Take just one of these examples, which shows how important antiknock volatility can be in certain regular grade gasolines.

The Critical Portion

Of all the cars manufactured between 1958 and 1961 that were designed to run on regular gasoline, 38% came equipped with manual transmissions. This "stick-shift" segment, produced in the past four years, represents the most critical share of America's regular-fueled car population. Because of their engine characteristics, and depending on the fuel's composition, these cars should perform well on gasolines that contain lighter lead alkyls.

In figure 1 above, regular gasoline "A" is such a fuel—a blend of light straight-run and

The reduction in price of antiknock compounds, announced after this advertisement had been prepared, alters to some extent the comparative values shown. The price reduction also emphasizes the potential profits that result from taking a new look at the position of lead in optimum economic refinery operation.

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COST THROUGH ANTIKNOCK SELECTION

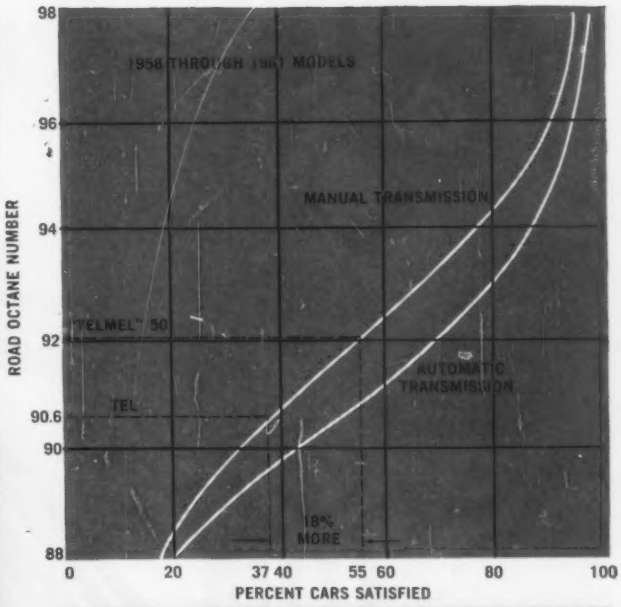

FIGURE 2
ROAD OCTANE NUMBER VS PERCENT OF CARS SATISFIED

reformate. Samples were treated experimentally with TEL, TML, mixed lead alkyls, and physical mixtures of TEL and TML. At the optimum antiknock treating cost of 0.53¢ per gallon (based on balancing reforming severity and TEL use), either 2.3 grams of "TELMEL" 50 mix or 2.65 grams of TEL met the lab specifications for the fuel. The selection therefore would be based on which antiknock provided superior road performance.

More Cars Satisfied

Figure 2 shows that the 90.6 road rating provided by TEL would satisfy only 37% of the manual transmission cars. With "TELMEL" 50, the resulting road rating of 92.0 would satisfy 55% of these cars—a gain of 18% more cars satisfied at the same treating cost.

This is only one of the antiknock selection situations facing the refiner—and only one of the rewarding opportunities open to him. It's typical of the problems Ethyl is well equipped to help *you* with. If you want assistance in selecting the most efficient antiknock for *your* refining requirements, call your Ethyl representative. He will also be glad to furnish you a copy of the WPRA paper referred to above.

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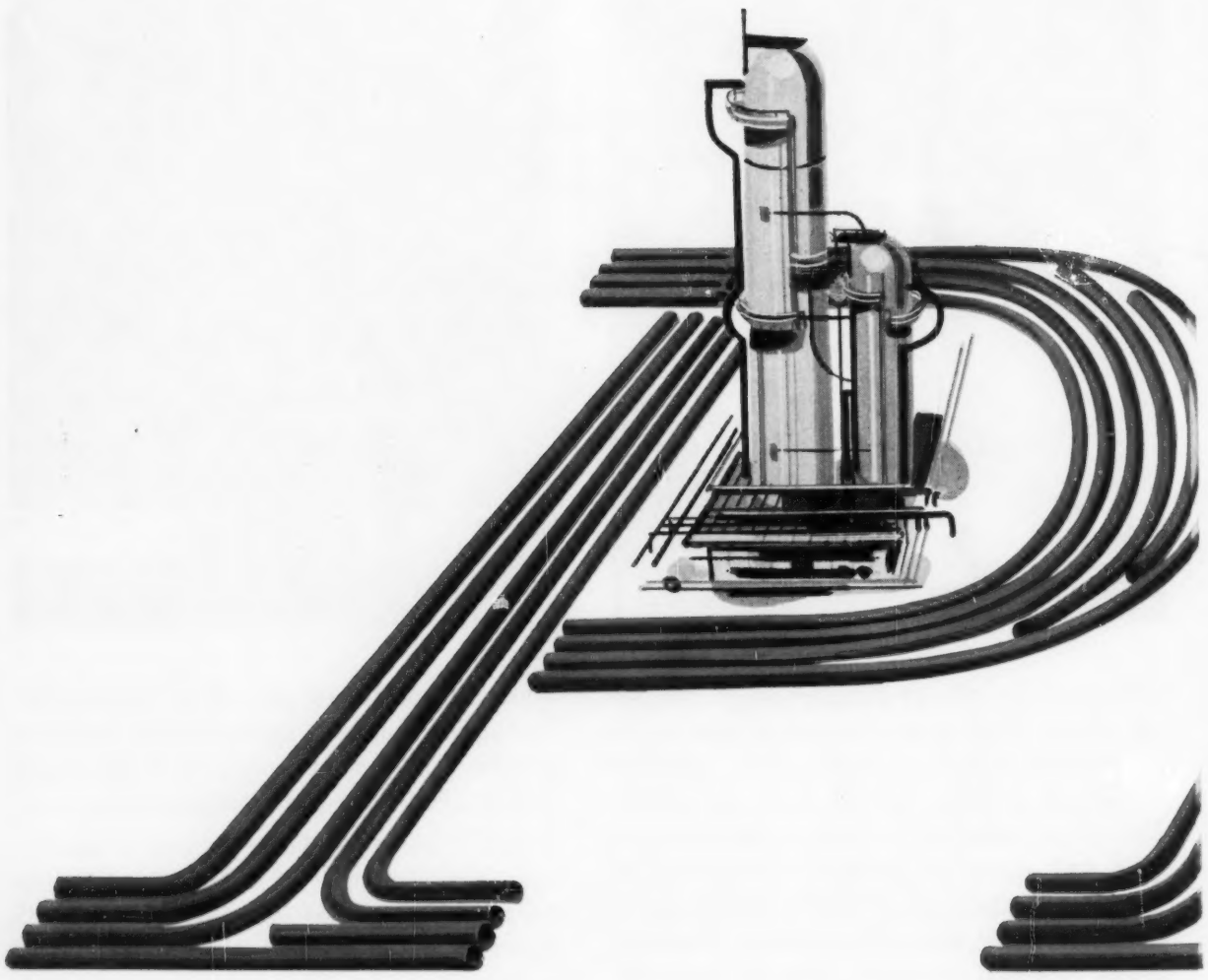

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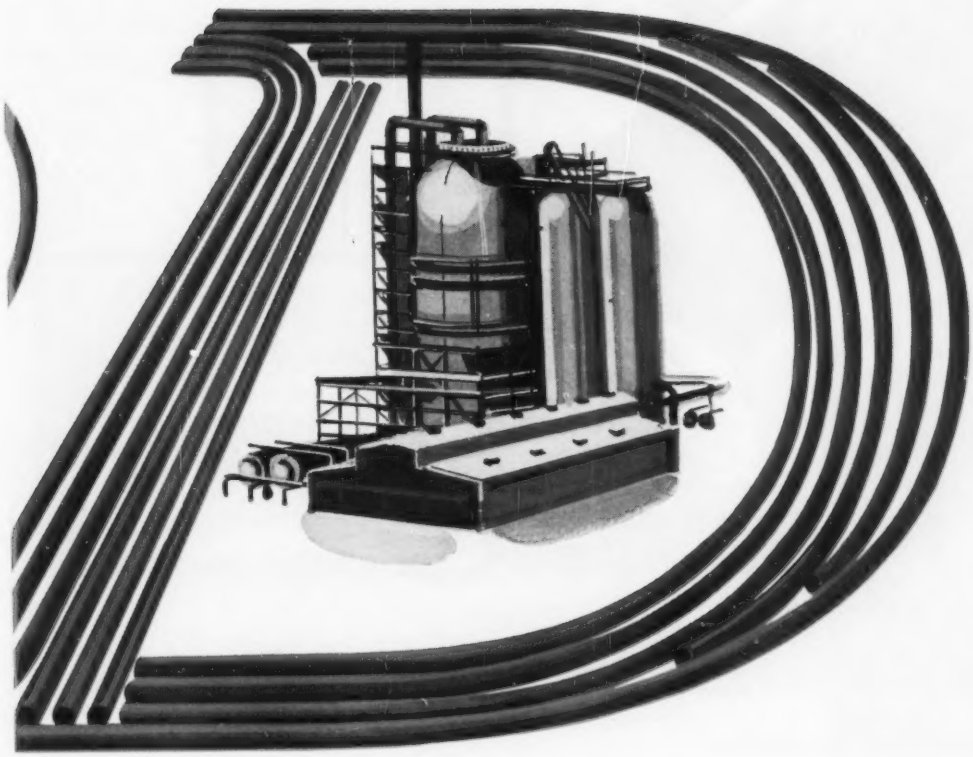

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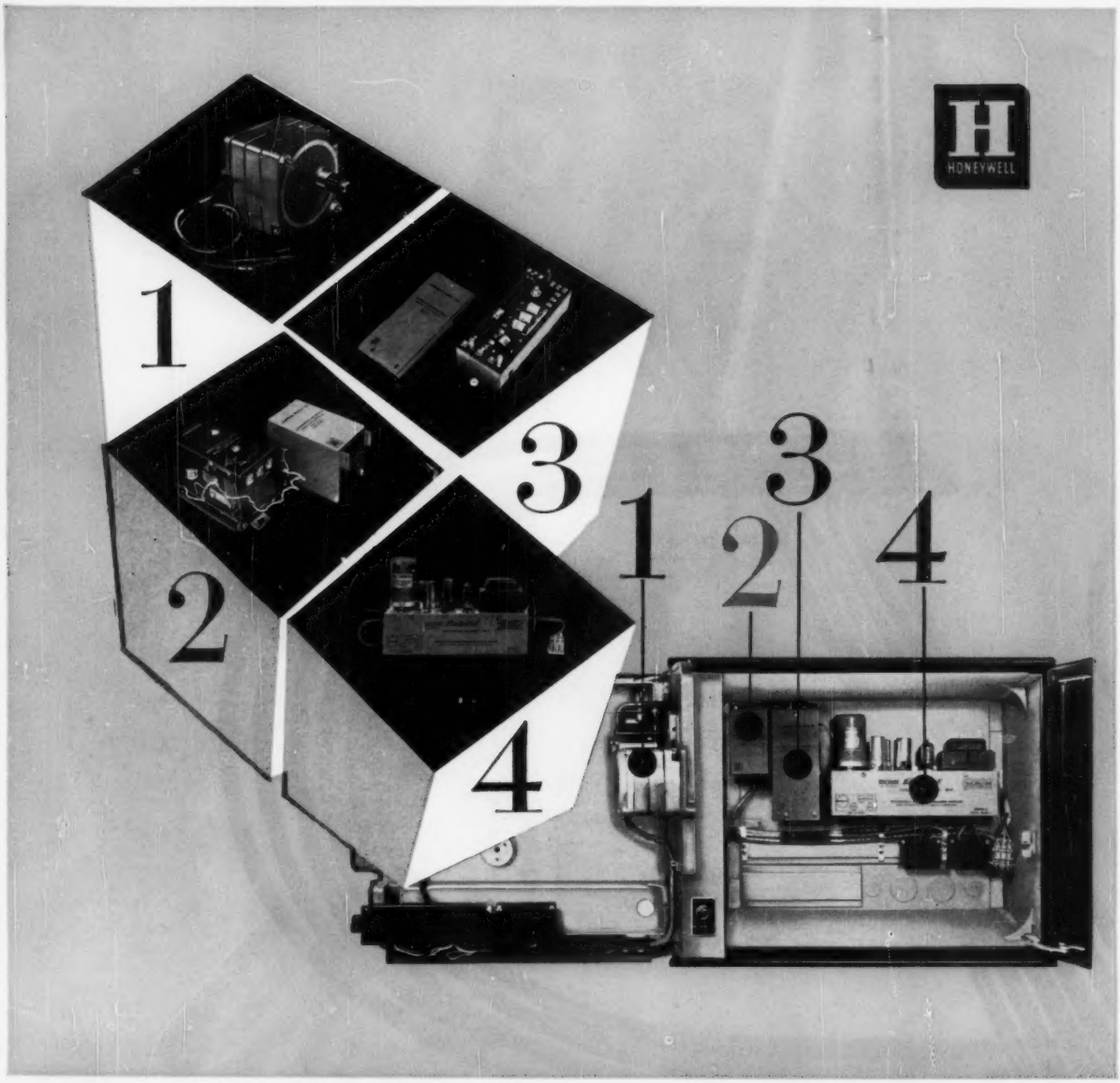

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INDUSTRY IQ QUIZ

Test your industrial IQ with this quiz on the current issue of HYDROCARBON PROCESSING & PETROLEUM REFINER

1. Plant Costs. Which of these expense items is not classified as a plant general expense? (a) purchasing, (b) accounting, (c) engineering, (d) raw materials.

2. Labor Costs. When estimating operating labor costs, how much should be added to the direct labor operating costs for supervision? (a) 15 percent, (b) 20 percent, (c) 25 percent.

3. Tank Farms. When designing tank farm dykes, the volume inside the dyke should be: (1) equal to the tank volume, (2) 1½ times the tank volume, (3) 2 times the tank volume, (4) 3 times the tank volume.

4. Acrylonitrile. What is the major market for acrylonitrile, acrylic fibers or nitrile rubber?

5. ASME Code. The ASME Unfired Pressure Vessel Code DOES NOT accurately predict stress values in standard ASME heads. True or false?

6. Maintenance. Few plants have installed computer-fed maintenance cost records mainly because maintenance engineers have not developed the necessary skills for data processing. True or False

7. Distillation. If you install an on-stream analyzer to measure boiling points, how close should the results agree with laboratory determinations? (a) ± 2° F, (b) ± 5° F, (c) ± 10° F.

8. Automation. When monitoring ability is a computers only recognized function in a $10-million plant, what is the most that one could pay for the computer installation and still have a three-year payout after taxes? (1) about $8,000 (2) about $80,000, (3) about $800,000.

9. Ethylene. When adding a 132-million-pound-per-year ethylene plant to an existing 50,000-bpd refinery, what would the ethylene manufacturing cost be per pound? (a) 3.7 cents, (b) 3.6 cents, (c) 3.65 cents per pound.

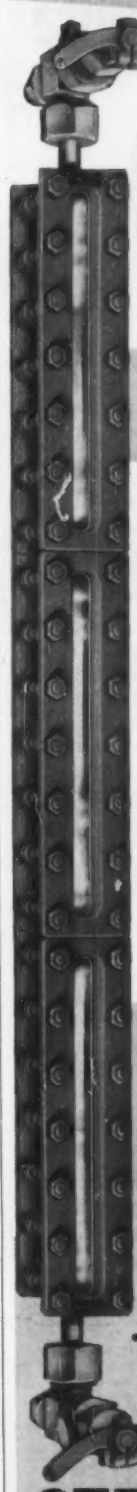
10. Reboilers. Which three of the following are advantages of the vertical thermosiphon reboiler? (1) cheap (compared to other reboiler types), (2) good for viscous fluids, (3) compact and easy to support, (4) satisfactory for low process flows, (5) easily cleaned, (6) good for fluctuating feed levels.

11. Human Physique. Science has proven conclusively that physique, or physical prototype, has nothing to do with our personality or the way we behave. True or False?

12. Nuisance Laws. Some recent decisions show that "nuisance" laws as they apply to the processing field, are getting fewer and fewer favorable decisions from the courts. True or False?

Answers on Next Page . . .

Strahman



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INDUSTRY QUIZ

(Answers to Quiz on Page 21)

1. (d). All other items must be distributed, overall production costs and are therefore general expenses. To find this and other points discussed in detail, see "How to Estimate Plant General Costs," **Page 123.**

2. (b). Usually 20 percent is enough to cover the unit's proportionate share for shift foremen, area supervisor, etc. For more details, see "How to Estimate Operating Costs," **Page 133.**

3. (2). The volume inside the dyke must be at least equal to the tank volume. For the latest information in tank farm design, see "Design Tips for Refinery Tank Farms," **Page 140.**

4. Acrylic fibers. Synthetic fibers now account for more than 70 percent of all the acrylonitrile produced. There are more interesting process and consumption facts in "Acrylonitrile—Petrochemical Prodigy," **Page 145.**

5. True. Recent computer investigations show that the empirical formulas given in the code predict low stresses under certain conditions of vessel geometry and pressure. For a simplified version of Galletly's method to improve stress predictions using edge influence coefficients, turn to "ASME Head Design Simplified Using Influence Coefficients," **Page 155.**

6. False. Perhaps not many plants have computer programs for maintenance cost control, but the reason is not lack of data processing skill. To get the advice of two Du Pont authors, see "Let Your Computer Compile Reports to Control Maintenance Costs," **Page 165.**

7. ± 2° F. For more about what to expect from continuous on-stream analyzers designed to measure boiling points, turn to "Measure Boiling Points Continuously," **Page 169.**

8. (2). This is correct assuming about a 0.5-percent return on original investment. For the details, read "Automation Today (Part 26)," **Page 175.**

9. (c). There is more to integrating an ethylene plant into a refinery than just manufacturing costs. To get the latest details, see "Add Ethylene Production for Profit," **Page 179.**

10. (1), (3), (5). The thermosiphon reboiler is not good for viscous fluids, is not recommended for low process flows or fluctuating feed levels. To get an analysis of six reboiler feed systems together with calculation check points, turn to "Reboiler Selection Simplified," **Page 189.**

11. False. It is true that judging people only by what we can "see" has been side-stepped as "unscientific," but some segments of science are re-examining the relationship between our bodies and our personalities, and coming to some interesting conclusions, some of which you'll find expressed in "Judging People by Physique (Part 1)," **Page 199.**

12. False. In fact, a study of recent and old court decisions reveals an "easing up" of the so-called nuisance law as it applies to refineries and other processing plants. To learn why, don't miss "A Court's-Eye-View of the Refinery 'Nuisance'," **Page 205.**

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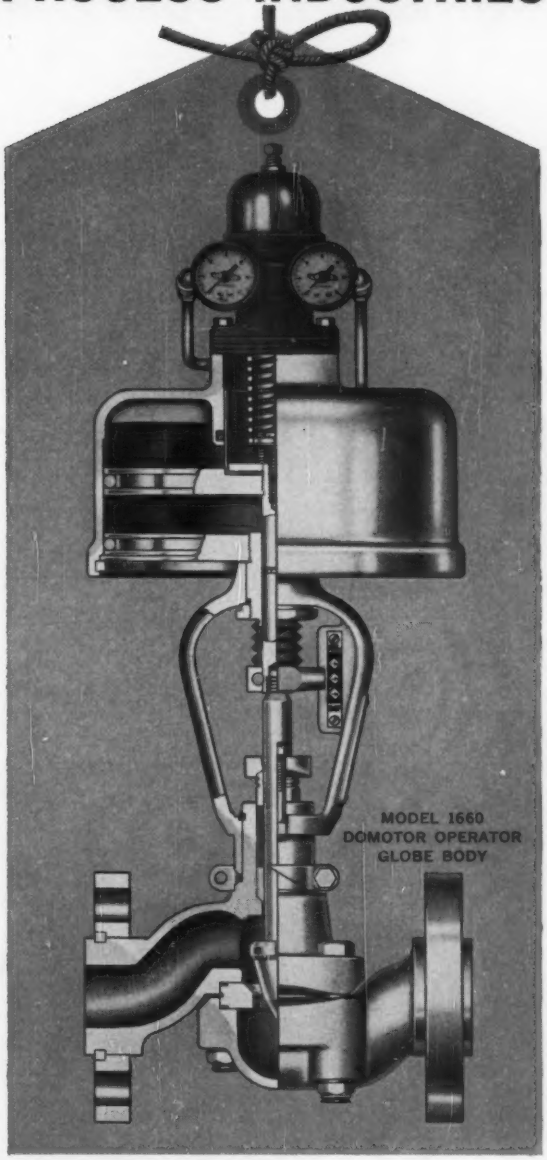

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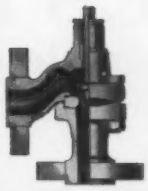

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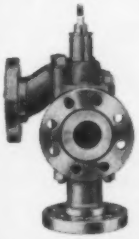

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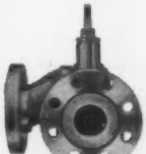

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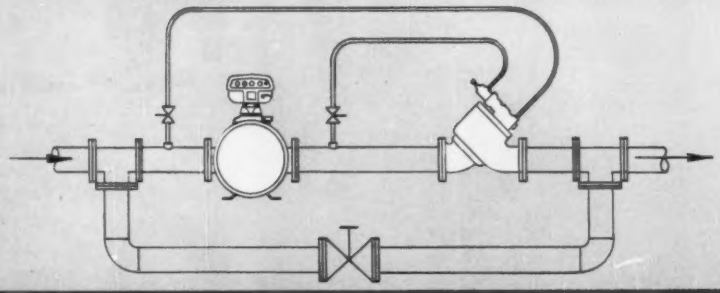

02V

The great interchangeable versatility of Brodie Series 500 Control valves makes them readily adaptable to almost any application you can name. By simply changing or adding pilot controls the valve is ready for service. Their fully self-contained, simple, compact internal porting of integral pilots avoids hazards of fragile external "plumbing." For positive responsive control with minimal pulsations look into Brodie Series 500 Valves. **Write, today for Bulletin 668.**

BRODIE

VALVES · METERS

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Remote Control
Diff. Pressure
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K&M SPRAYED "LIMPET" ASBESTOS® thermal insulation provides you with a tidy savings of 35% on labor costs for installation.

One man with a spray gun can cover up to one-third more surface daily with this modern material than with conventional block-type thermal insulation. Even in out-of-the-way or cluttered areas or on irregular shapes, installation is fast and frugal. No longer required are bands, fastening wires, cutting, mitering, fitting and stuffing. K&M SPRAYED "LIMPET" ASBESTOS offers a modern solution to rising labor costs.

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- **100% asbestos fiber, spray-type thermal insulating material.**
- **Fits curved or irregular surfaces permanently, regardless of temperature changes.**
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FREE literature on the properties, cost-saving features, many uses and the application of SPRAYED "LIMPET" ASBESTOS is available to you. To get your copy . . .

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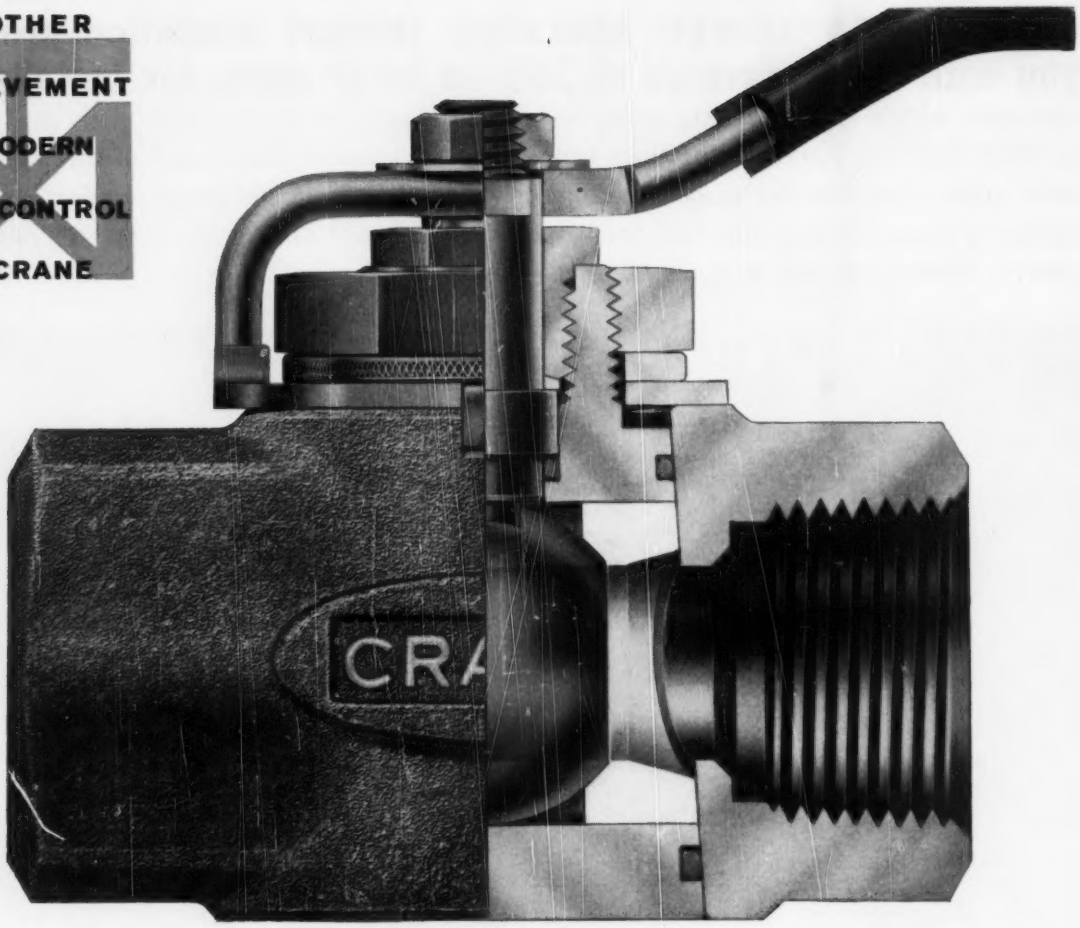
For more data on advertised products, use cards, last page.

ANOTHER ACHIEVEMENT IN MODERN FLOW CONTROL BY CRANE



this ball beats all!

CRANE BALL VALVES are engineered for superior flow control and minimum-maintenance operation. The secret of this valve's all-around outstanding performance is its beautifully simple, Crane-designed tapered cartridge containing all the working parts. While the valve body remains in line, acting as a pipe connection, the entire cartridge may be removed from the bottom, quickly and easily, for fast exchange or simple, low-cost maintenance.

Precision pre-loaded Teflon* seats assure bottle-tight closing in either direction with a quick, easy quarter turn of the bright, Crane orange insulated handle. The self-aligning, precision machined ball is polished and chrome-plated to reduce friction and wear on the self-cleaning seats. All steel parts are plated for corrosion resistance. Crane Ball Valves handle fluid, gas and air services from vacuum to 800 psi and temperatures from –40 to 400F. Available now from your Crane Distributor for prompt delivery—sizes from ¼" to 2", screwed ends, in bronze, carbon steel, and Type 316 Stainless.

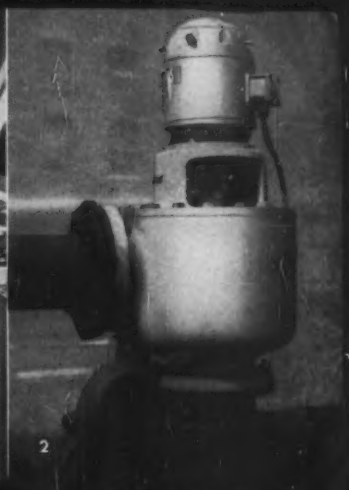
*Registered DuPont trademark.

at the heart of home and industry

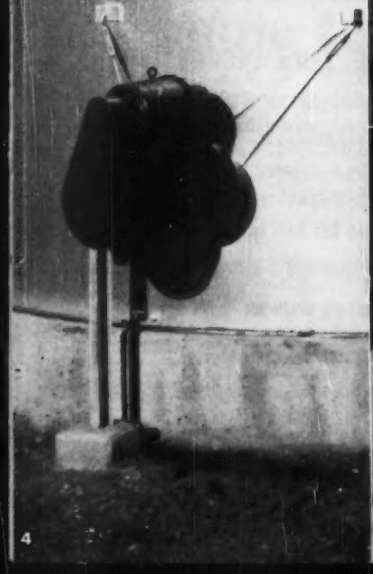
CRANE

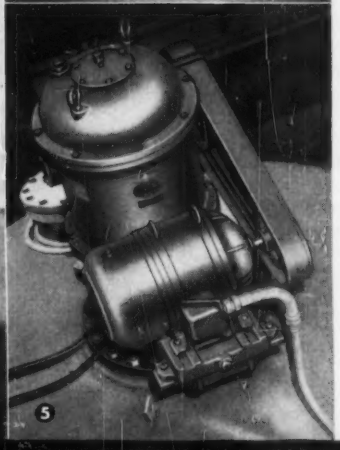
valves
piping • electronic controls
plumbing • heating
air conditioning

Contact your Crane Distributor or write: Crane Co., Industrial Products Group, 4100 S. Kedzie Ave., Chicago 32, Ill., for illustrated brochure ADB 1001 with complete information on Crane Ball Valves. In Canada: Crane, Ltd., 1170 Beaver Hall Square, Montreal.



Improved Processing through Engineered Agitation





HOW IMPORTANT IS GOOD FLUID MIXING IN YOUR PROCESS?

REGARDLESS OF HOW SPECIALIZED your particular processing needs are, good mixing can be the difference between "run of the mill" and maximum yields.

NETTCO MIXERS ARE PROCESS-RATED for optimum performance. Your particular process requirement is fully evaluated. And—it costs no more to get the full benefit of Nettco's wealth of agitation technology and broad application experience. Then—from design and pilot test to full process conditions, standard components are precision teamed to provide you with a Nettco mixer to meet your most exacting conditions. If good fluid mixing is vital to your process, then Nettco Engineered Agitation is vital to *you!*

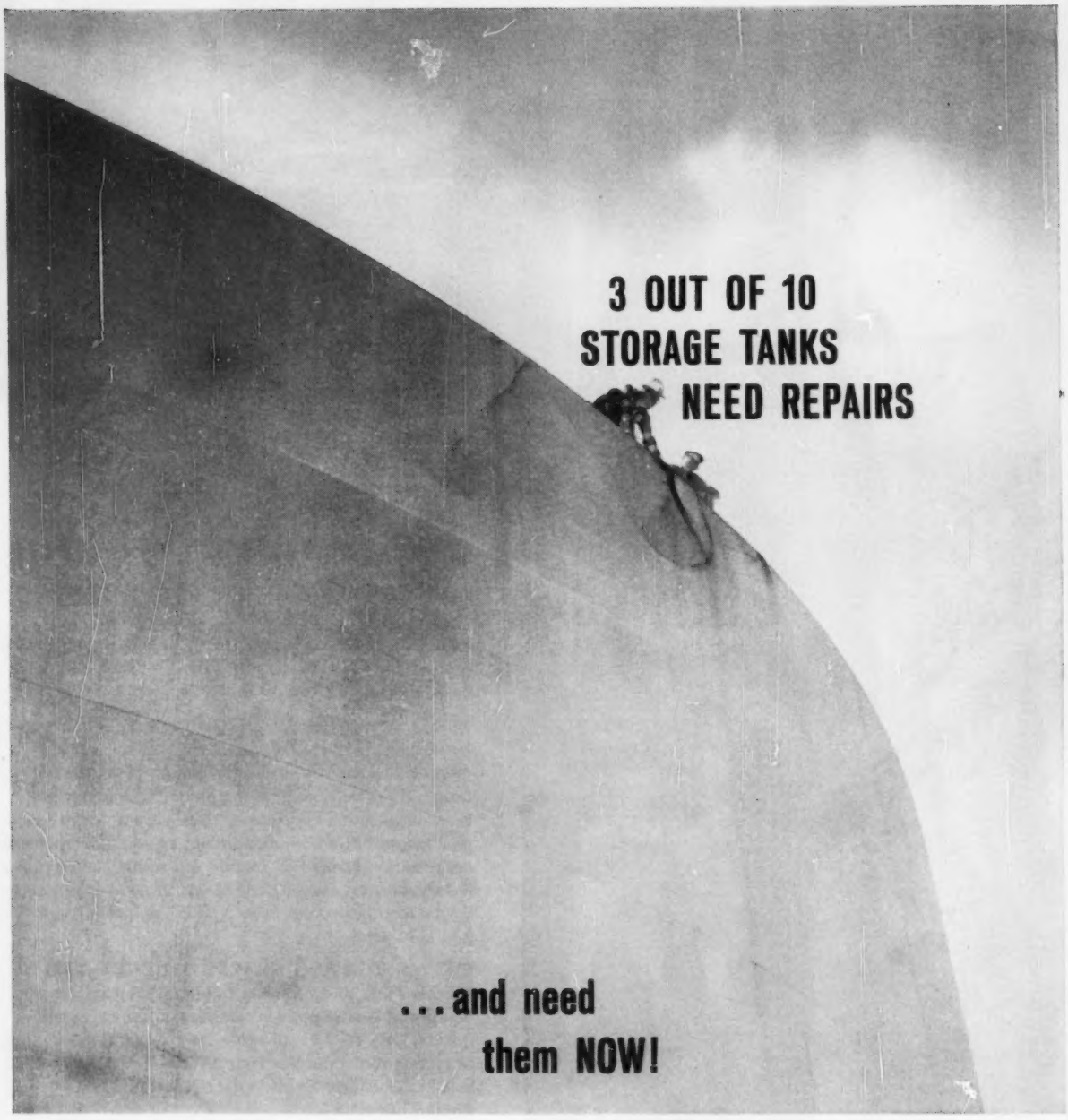
PUT NETTCO ENGINEERED AGITATION TO WORK FOR YOU. From a full line . . . side drive, tank top, portable or tripod and unique continuous pipeline mixers, NETTCO can provide the answers to a wide range of mixing problems. See your NETTCO representative listed in Chemical Engineering Catalog or Refinery Catalog, or write for Bulletin 582, New England Tank and Tower Co., **81** Tileston Street, Everett 49, Mass.

NETTCO

ENGINEERED AGITATION SPECIALISTS

EVERETT 49, MASSACHUSETTS

1. Paint blending with Nettco tank top mixers on 400 gallon portable tanks.
2. Nettco Flomix® in the continuous recycling of waste product to improve yield.
3. Variable speed pilot plant application of Nettco medium speed, propeller drive mixer.
4. Raw material batch blending with Nettco side drive mixer to assure uniformity.
5. 15 year old Nettco tank top mixer for synthetic rubber production with one of first double mechanical seals.



How good (or bad) is your tankage?

An inspection may surprise you. Since Feb. 1st, Graver inspectors have examined a total of 349 storage tanks for a number of refiners and producers. More than 10% of these tanks needed major repairs. More than 20% needed lesser repairs. Many needed repairs *immediately*—in order to prevent total loss of the tank, or a major capital expense later on.

The fault is no one's. It's just that few companies have the time, the equipment or the personnel to do an efficient job of tank maintenance.

This is where Graver comes in. Our Free Inspection Plan enables you to get a 73 point check on all your storage tanks—FREE. Should repairs be necessary, Graver does the job quickly, expertly and at a competitive cost.

Graver is the *only* nation-wide Tank Repair and Maintenance Service. We have our own crews, our own special equipment. We come in, get the job done, and get out—with no interruption to your production schedule, no need for you to divert your operating forces to handle maintenance work.

Have you a tank problem?
Call Graver.

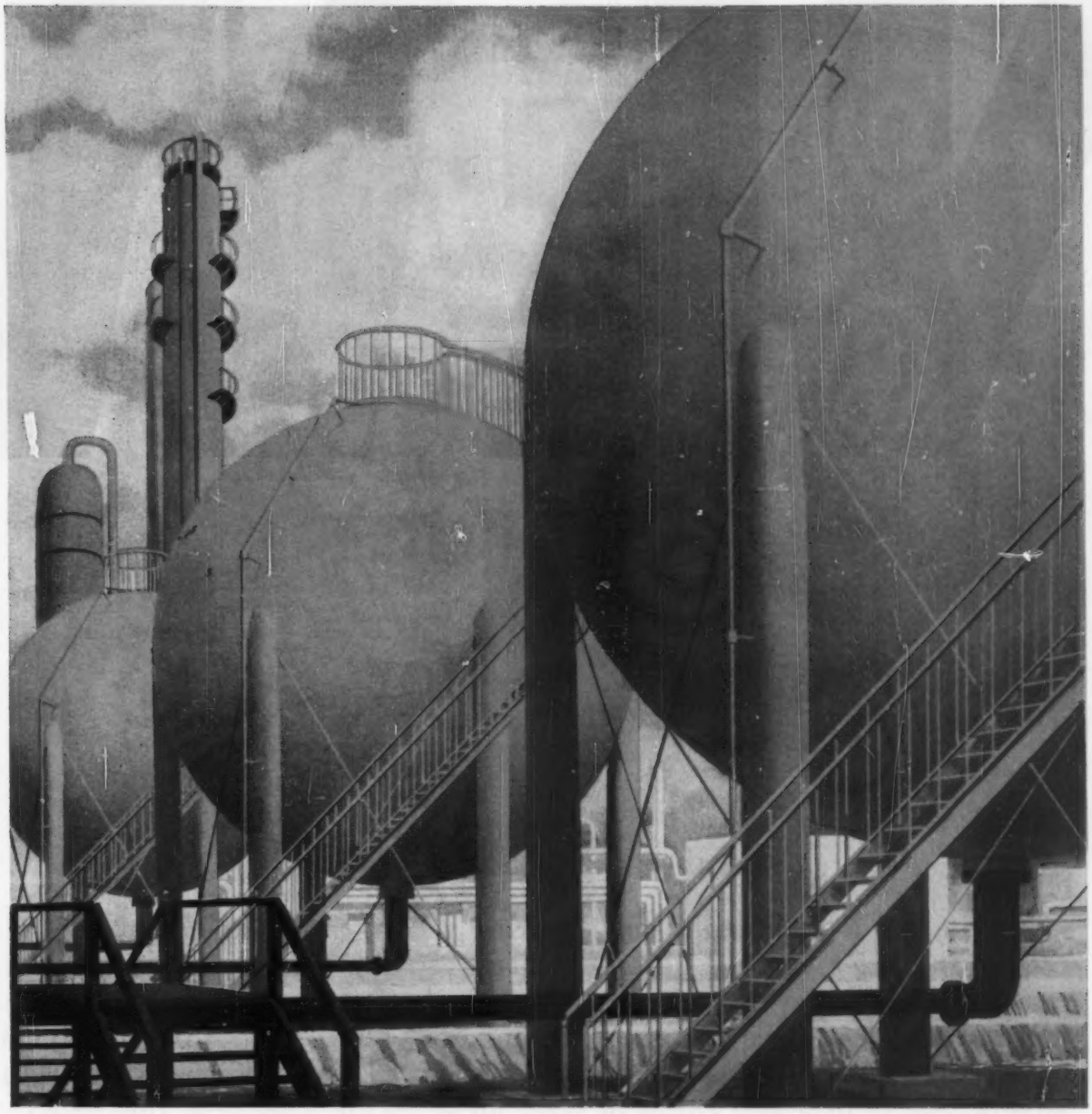
FREE TANK INSPECTION

Graver will make a thorough 73 point check on all your storage tanks and give you a detailed "Condition Report" on each one—*free of charge*. No obligation, of course.

Write for full information.

Graver — One of the UNION Tank Car Companies

Graver Tank & Mfg. Co.
Suite 2122—35 East Wacker Drive
Chicago 1, Illinois



Durable tank paints that keep uniform color

That's what you get when you specify paints made with M50® Basic Lead Silico Chromate pigment

Paints made with *M50*® Basic Lead Silico Chromate have remarkable resistance to chalking and color change, even in harsh atmospheres.

And Basic Lead Silico Chromate can be tinted in an unusually wide range of colors—colors that can convert your tanks and installations into attractive goodwill builders for you. *M50* pigment also provides excellent rust inhibitive properties and outstanding weather resistance.

M50 pigment can be used in every coat, to build up "Defense-in-Depth" against corrosion and weather-wear.

The anti-corrosive action goes from the primer up through the finish coat. The durability goes from the finish coat down through the primer.

• • •

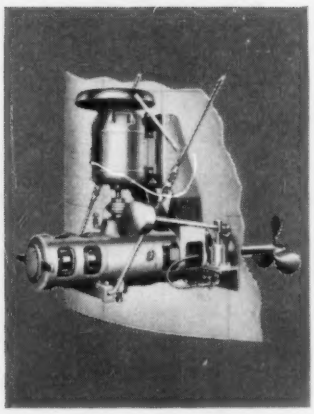
Next time you buy paint for decorative metal protection, specify paints made with *M50* Basic Lead Silico Chromate.

M50 an oncor *Pigment...A Development of* National Lead Company

General Offices: 111 Broadway, New York 6, N.Y.

For more data on advertised products, use cards, last page.

NEW



for blending

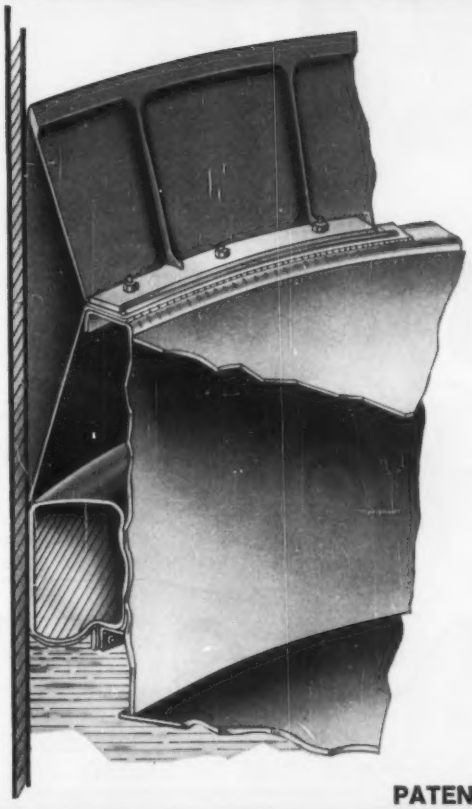
Beginning today, all other side-entering mixers are out of date. ¶ The LIGHTNIN Mixer you see here is a 50-horsepower Hi-Flo unit. It does the work of *three* 25-hp mixers on a big blending tank. ¶ It saves you one-half the purchase price of three 25-hp mixers • almost two-thirds the installation cost • and one-third of the operating cost. ¶ You can now get LIGHTNIN Mixers like it in a *full range of sizes up to 50 hp.* This new line provides 50% more flow per horsepower than any other side-entering mixer. It is called LIGHTNIN Series NSE. ¶ At every size level, these units equipped with new Super-Pitch propellers provide extra pumping capacity. Capacity that translates into faster blending or blending at lower installed cost. ¶ For information, call your LIGHTNIN Mixer representative now. He's listed in Refinery Catalog and in the yellow pages of your telephone directory. Or write, wire, phone us direct for Bulletin B-526.

Lightnin® Mixers
MIXCO fluid mixing specialists

MIXING EQUIPMENT Co., Inc., 164-g Mt. Read Blvd., Rochester 3, N.Y.
In Canada: Greey Mixing Equipment, Ltd., 100 Miranda Ave., Toronto 19, Ont.
In Europe: Lightnin Mixers, Ltd., Poynton, Cheshire, England

ALL FLOATING ROOF TANKS ARE FULLY EQUIPPED, **BUT...**

Only Tubeseal Has Lightning-Proof, Electro-Conductive Weather Shield



PATENTED

Tubeseal electro-conductive weather shields are an *exclusive tried and proved development.* They provide positive protection against lightning-caused rim fires. ■ How? By maintaining a *continuous* grounding bond between roof deck and shell—concentration of static charges is impossible. There has *never* been a lightning fire where any of the many hundreds of Tubeseal System Floating Roof Tanks are installed throughout the world—they're "lightning proof." ■ This is scientific and safe storage protection for the entire range of volatile products. Tubeseals can be installed on any of your tanks—new, old, riveted, or welded. You owe it to the future safety of your conservation facilities to investigate. Send for the Tubeseal Bulletin now—it could be important.

PDM
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Pittsburgh-Des Moines Steel Company

12 plants to serve you coast to coast

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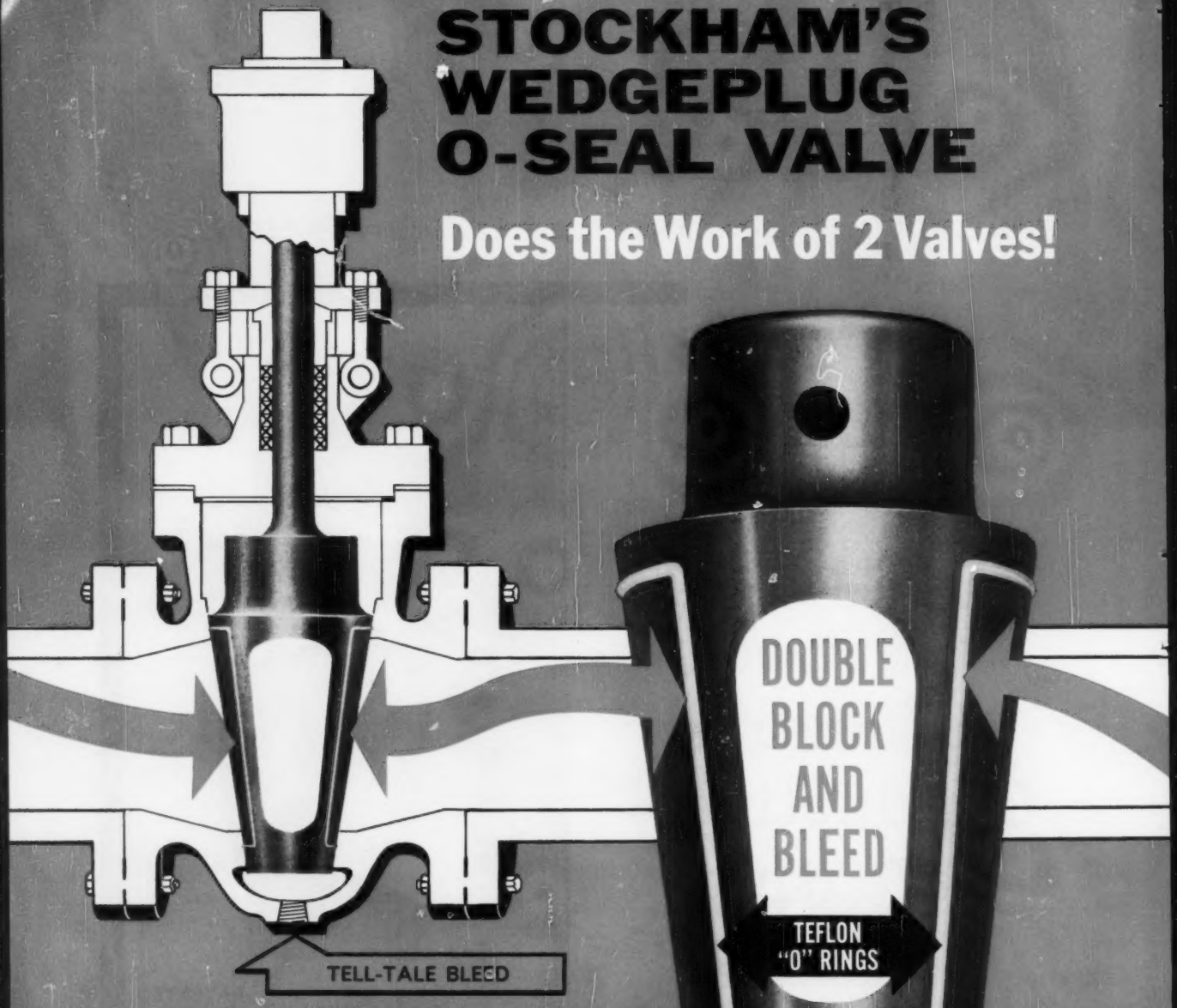
STOCKHAM'S WEDGEPLUG O-SEAL VALVE

Does the Work of 2 Valves!



BUBBLE-TIGHT SHUT-OFF on both the upstream and downstream seats is provided by the pressure-sealing effect of the two Teflon*"O" rings in the plug.

FIRESAFE: If Teflon "O" rings are burned out, an effective shut-off is made by ground metal to metal seats.

TELL-TALE BLEED to check valve performance assures no product mixing in manifold.

NON-LUBRICATED — the O-Seal eliminates the high daily cost of lubrication, as well as the danger of product contamination caused by plug-seal lubricants.

GUARANTEED not to stick.

*Teflon Dupont tradomark

AVAILABLE THROUGH YOUR LOCAL STOCKHAM DISTRIBUTOR
Bronze, Cast Iron, Ductile Iron, Cast and Forged Steel Valves
Cast Iron, Malleable and Ductile Iron Pipe Fittings

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VALVES *and* FITTINGS

General Offices and Plant
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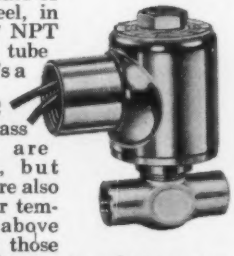
HOKE Flow Sheet 5
HOKE REPORTS ON FLUID CONTROL

WE'VE TOSSED A NEW BALL INTO AN OLD GAME

A VALVE NAMED "DESIRE"

With apologies to Tennessee Williams, we really have produced a Solenoid Valve line based on *your* desires. We surveyed all the solenoid valve users we could find to determine what *you* wanted. The result is Hoke's "User Designed" Series 90 and 95, two-way and three-way, direct-acting solenoid valve line.

Thanks to you, we have much to brag about. Here's what we have been saying about these new valves: lightest weight – smallest size – no-hum operation – lowest temperature rise – lowest power consumption – stainless steel plunger – silver AC shading coils – easiest installation – packless construction – 360° rotatable housing – operates in any position.



We make them of forged brass or stainless steel, in ⅛" and ¼" NPT size or JIC tube ends. There's a variety of AC and DC voltages. Class "A" coils are standard, but Class "H" are also available for temperatures above 212°F. For those with high insurance rates, we can supply explosion proof coil housings.

Now that we've bragged a bit, we must also apologize for our premature enthusiasm. We were so excited about this product that we stirred up a hornet's nest of interest before we were ready to deliver in quantity. Shipments were slow at the start, but now we can have any reasonable quantity of these "desirable" solenoid valves "on-stream" in your plant when you want them.

There's only one way to get conclusive performance proof – buy a valve. Ask for Bulletin SV-4-61.

A STEADY FLOW OF FACTS!

Further flow features, and interesting technical topics are carefully covered in Hoke's technical publication, the FLOW SHEET. It's free, but worth millions! To get the full benefit of our engineering and editorial efforts six times a year, mark your "X" in the proper box.

The technique of molding polyvinyl chloride into ball valve parts is old hat. Even the unplasticized compounds of type I PVC have been kicked around for a while (with minor successes). But until now, no one has booted the ball for a goal.

Perseverance, determination, and the pursuit of economic reward have prompted us to offer a line of ball valves molded of the toughest grade of type I, unplasticized PVC. There are no foreign agents to contribute to a corrosive demise, even in most caustic services. It even meets the proposed new ASTM specification and has a tensile strength of 8500 psi. Those who have had PVC piping problems will profit from the new molding process that gives these Hokes dimensional stability and very high impact strength. Sensitive systems, human and otherwise, are safe from contamination – they're absolutely non-toxic. We've set 140°F. as the operating temperature limit, but occasional excursions to 160°F. won't do any harm.

All standard models are supplied with a concentric hole drilled thru the ball. They can be heat welded, or solvent bonded right in the line. Piping hook-up is even simplified by their coupling-like assembly. Your assistant can fit each half of the valve to a pipe end, then reassemble the valve without having to turn the pipe. Pressures to 125 psi are duck soup for these valves.

A maintenance man's delight, they can be cleaned and have their seats changed without leaving the pipe. Their light weight makes them ideal for use on long, unsupported spans of pipe.

Size-wise [illegible] offering them in ½, ¾, 1, 1½, 2, and 3 inch sizes, all NPT female connections.

You will command the eternal admiration of your colleagues when you install these valves. Be the first to show your rightful status by ordering a shiny new Hoke polyvinyl chloride ball valve. If pride of ownership hasn't motivated you at this point, the mere fact that you are behind the scientific times should move you to find out more.

It isn't necessary to tell us why you want the additional information. Just check the coupon below. We'll forward the facts in a plain, brown envelope.

'61 PRODUCT PARADE

You'd be surprised at some of the screwball ways our valves have been used (to decided advantage, of course). Hoke distributors are armed to their maxillary third molars with this method madness and will redesign your systems (incorporating solenoid valves and PVC ball valves) at the drop of a postcard. Check the PRODUCT PARADE box.

Hoke's Performance Guarantee — *Every Valve Leak-Tested!*

HOKE, INCORPORATED
167 Piermont Road, Cresskill, N. J.

Send me complete information on the Hoke products checked below:

- ☐ PVC Ball Valves
- ☐ Solenoid Valves
- ☐ Product Parade
- ☐ Flow Sheet
- ☐ Complete Catalog GC960

NAME _____ TITLE _____
COMPANY _____
ADDRESS _____
CITY _____ STATE _____

SEE OUR CATALOG IN SWEETS PRODUCT DESIGN FILE

For more data on advertised products, use cards, last page.

take NEWTHERM on test!

Test its STRENGTH

NEWTHERM is unusually strong and rigid—a feature of special importance in the larger, more vulnerable sections. Put a sample section or slab on part of your plant and *prove for yourself* its outstanding ability to withstand impact and water damage. See how it withstands rough handling in transit and erection, minimising breakage in shipment and erection by unskilled labour at the most remote sites.

Test its MOISTURE RESISTANCE

Even totally immersed in water, NEWTHERM retains much of its strength and rigidity. It does not become deformed when in contact with water, thus work-in-progress need not be covered. Especially on contracts where weather conditions would delay the application of insulation—NEWTHERM is the material to use.

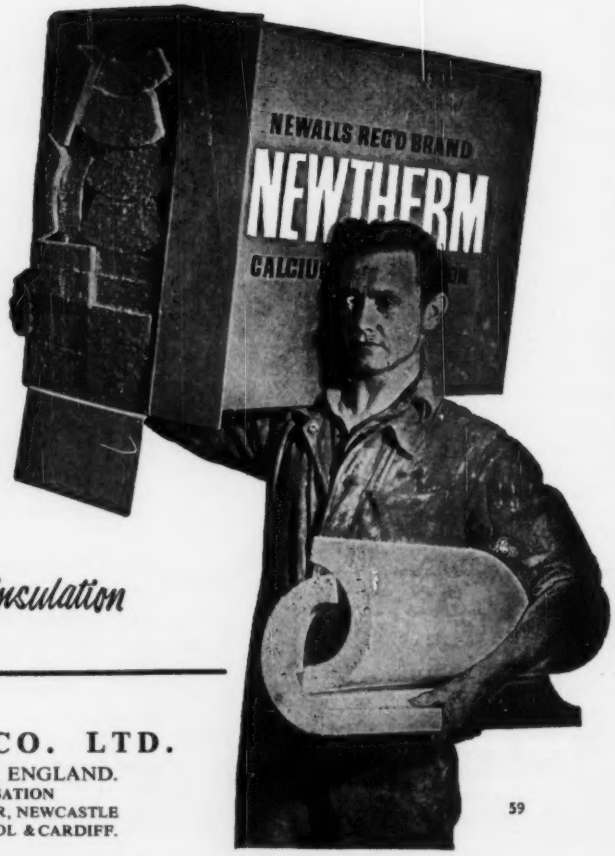
Test its LIGHTNESS

Unusually light for such a high-efficiency material, NEWTHERM compares favourably in this respect with other insulants far inferior in strength. That means easier handling and fewer breakages—even the largest section is easily carried in one hand.

Test its EASE OF APPLICATION

Undoubtedly, NEWTHERM is one of the easiest of materials to apply. It is supplied in plastic form and in a wide range of standard-sized sections and slabs, smoothly finished and straight edged for immediate fitting. The finished job is very neat, with minimum joints, and appliers particularly appreciate the handleability of the material—especially in difficult situations.

READ ALL ABOUT NEWTHERM in a specially prepared booklet. Sizes, compressive strength, thermal conductivity,—this and much more useful information can be on file if you write for your copy now, to the sole manufacturers Newalls Insulation Co. Ltd.



NEWALLS (Reg'd Brand)

***NEWTHERM** calcium silicate insulation*

. . . for temperatures up to 1400°F.

NEWALLS INSULATION CO. LTD.

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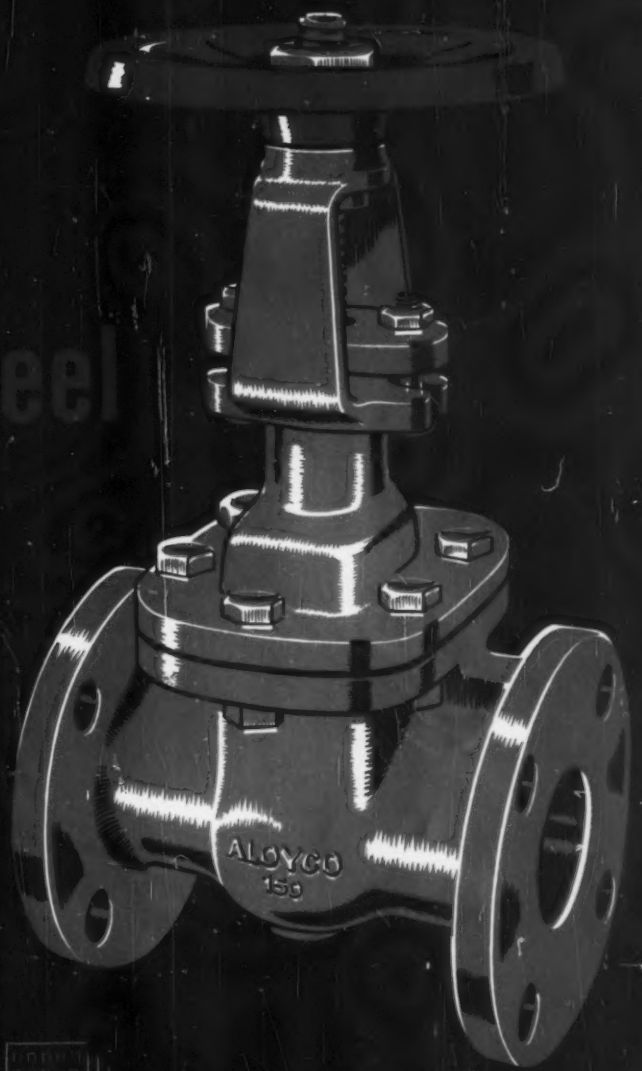
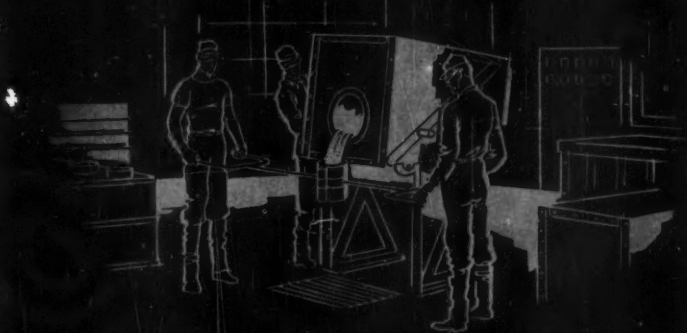
A member of the TURNER & NEWALL ORGANISATION
Offices & Depots at: LONDON, GLASGOW, MANCHESTER, NEWCASTLE UPON TYNE, BIRMINGHAM, BELFAST, DUBLIN, BRISTOL & CARDIFF.
Agents and Vendors in most markets abroad.

59

we make stainless steel valves ...nothing else



ALOYCO 111 Gate Valve for 150 lb. service features double disc ball-and-socket wedges. They are free to rotate and are non-fouling in any position which insures tight closure. There are Aloyco valves and alloys designed for every type of corrosive service.

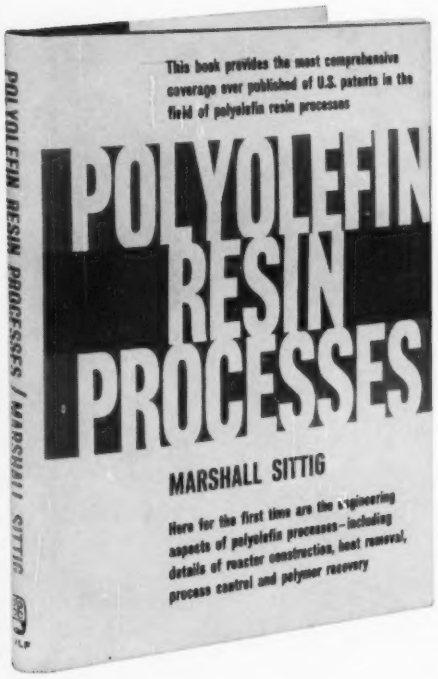


SPECIALIZATION! Isn't it reasonable to believe that the one company with experience, facilities, research and service all devoted to a single product is your best source of supply? The modern Aloyco foundry, for example, is designed to produce one end product only: pressure-tight Stainless Steel Valve castings of the finest quality.

ALLOY STEEL PRODUCTS COMPANY
LINDEN, NEW JERSEY

Longer Lasting
ALOYCO
VALVES
1ST IN CORROSIVE SERVICE

Just Published


This book provides the most comprehensive coverage ever published of U.S. patents in the field of polyolefin resin processes
POLYOLEFIN RESIN PROCESSES
MARSHALL SITTIG
Here for the first time are the engineering aspects of polyolefin processes—including details of reactor construction, heat removal, process control and polymer recovery
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By Marshall Sittig

240 Pages, 65 Figures, 14 Tables

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This book provides the most comprehensive coverage ever published of U.S. patents in the field of polyolefin resin processes.

Here for the first time are the engineering aspects of polyolefin processes—including details of reactor construction, heat removal, process control and polymer recovery.

ABOUT THE BOOK

In this book the reader will find all U.S. polyolefin patents listed in order of application. This listing contains patent application serial number, date, U.S. patent number and book reference number.

It covers solid (rather than liquid or viscous) polymers and concentrates on resins, homopolymers of aliphatic mono-olefins and some copolymers of olefins with other olefinic hydrocarbons.

It also covers the process starting with olefin raw material and concluding with a purified polymer.

Thus it includes catalyst and solvent recovery with attendant steps between olefin and polyolefin. Admixture of aluminum alkyls and other compounds to produce the actual complex metal catalysts are considered.

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TECHNOLOGY

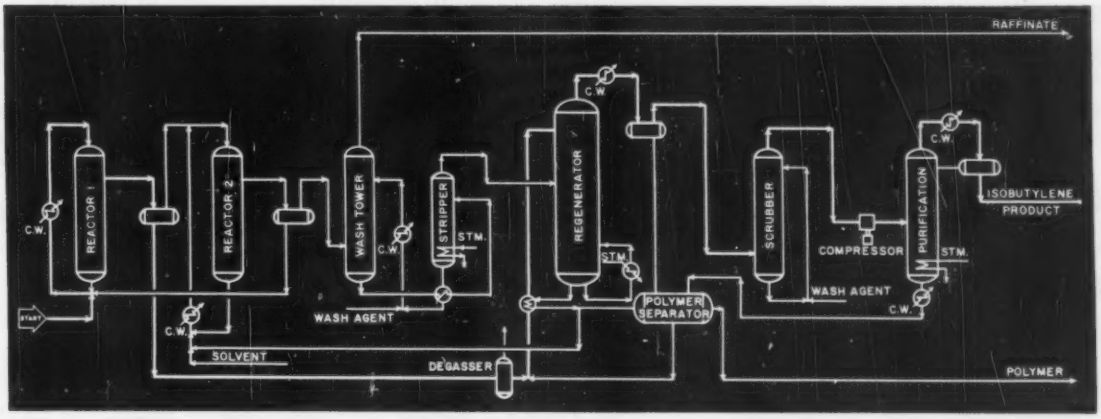
New isobutylene process

A new extraction process developed by Badger Manufacturing Co. claims advantages in the production of high-purity isobutylene or the removal of isobutylene from other olefins. (Flow chart below)

The process is sublicensed by Badger through CFR (Compagnie Française de Raffinage), discoverer of the process. Since 1959, Badger and its European affiliates have been actively working with that company in the improvement and engineering of the process to commercial-scale operation.

Full pilot plant tests show the advantages of the process in C_4 olefin processing are: minimum losses to polymer formation; high yields of exceptionally pure isobutylene product are routine; raffinate of very low isobutylene content can be produced if desired; feeds high in butadiene are readily processed. A recent test run with feeds containing 35 percent butadiene produced these results: isobutylene product purity, 99.4 percent; yield 86 percent; butadiene recovery in raffinate, 98 percent; less than 2½ percent isobutylene remained in the raffinate; raffinate met specifications for LPG concerning residue of evaporation (without redistillation); solvent remained clear and unaffected.

The process scheme calls for the contacting of feed and solvent, phase separation, stripping of solvent and redistillation of isobutylene for purity. Since there is no butane contamination of product, further fractionation is not required. Steps requiring reconcentration or repurification of the solvent are also eliminated.



A new petrochemical

Pan American Petroleum is successfully producing higher-molecular-weight carboxylic acids by adding low molecular carboxylic acids to primary olefins. Two processes the company is examining include photo initiation with ultraviolet wave lengths and free radical initiation by peroxides. Says Pan Am, the former method is the better of the two. Reason: Products are uncontaminated by chemical-initiator fragments, power costs less than two cents per pound of product, and the process is adaptable to continuous operation. Applications: As cobalt and manganese solubilizers for paint and printing ink drying catalysts, free-radical polymerization of sluggish monomers and addition of alkylbenzenes to terminal olefins.

Isoprene at less cost

A new low-cost isoprene production process that may give polyisoprene a lead on other kinds of synthetic rubber has been developed by the French firm, Institute Francais du Petrole. The process has already been licensed to El Paso Natural Gas, Cities Service, Mitsubishi Chemical, Nippon Gas, Ube Kosan and Toyo Koatsu. The Institute has a pilot plant operating at its research center near Paris. A French company plans to build a small semi-commercial unit some time this year, in which other licensees of the process are expected to participate.

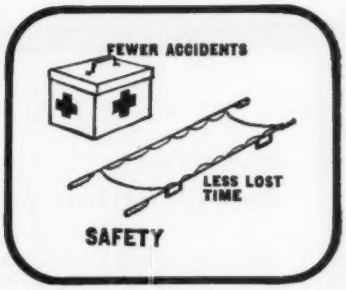
Chemical automation

One big problem in automating industrial chemical processes is that it is often hard to get accurate and continuous information on process stream's composition. Answer to the problem, according to a report by Battelle Memorial Institute scientists, may be to add intrinsic radiotracers—radioactive isotopes of chemicals being processed—to process stream.

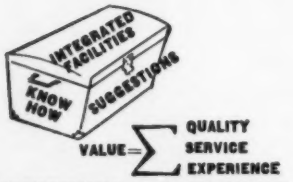
Thus far, continuous information on composition of chemical process streams is provided by measuring such physical properties as density, electrical conductivity, oxidation potential, refractive index, x-ray absorption, and infrared, ultraviolet, and visible light

When evaluating a product—

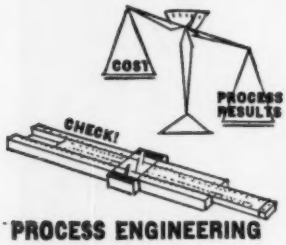
Your Safety Department Reviews Product Design With Respect to Strength, Weight, Ease-of-Handling, and Other Factors That Affect Extent of Workmen Hazards . . .



Glitsch Engineers Carefully Review Product Design for Safety as Well as Function—



ENGINEERING & ESTIMATING



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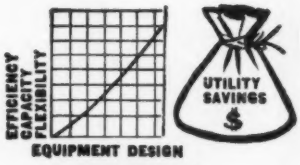
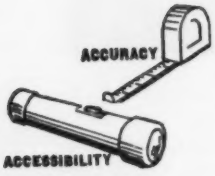
It is realized by Glitsch that industrial accidents and lost time are costly, both to our customers and their personnel.

The added cost for the "plus-factor" of safety and structural stability of Glitsch products is minor if you compare "value received" from Glitsch designers.

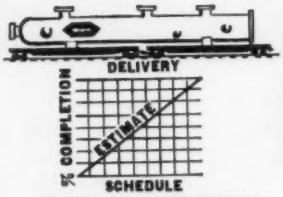


OPERATING

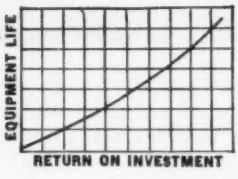
MAINTENANCE



INSPECTION



FIELD CONSTRUCTION



EXECUTIVE

PURCHASING

PRODUCTS — Glitsch Lightweight "Truss-Type" Ballast Trays, Sieve, Bubble Cap, Dualflow, Disc, Donut, Accumulator, and Mist Eliminator Trays . . . Pressure Vessels, Contactors, Reactors, Filters, Heat Exchangers, and Other Specialty Products . . . Bubble Cap and Riser Assemblies, Flanged and Dished Heads, Machine Time, Stampings, Knitted Wire and Woven Wire Screen.

TECHNICAL — **Fractionating Tray Engineering:** Process, Mechanical, Structural, and Metallurgical Designing. **Pressure Vessel Engineering:** Pressure, Temperature, Wind, Earthquake, and Dynamic Designing. **Special Product Engineering:** Research and Development and Model Mock-Up. **Special Tooling and Machine Design** for Specific Purposes and Problems.

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absorption. But in many cases instrumentation is expensive and current instruments are not readily adaptable to plant conditions. Also process may be so complex, physically and chemically, that it is difficult both to make measurements and interpret results.

Solid rocket fuels testing

New $250,000 facilities for testing solid rocket fuels, including an 18-foot sphere that simulates space conditions, have been put into operation at Linden, N. J., by Esso Research. Besides space sphere, they include laboratory housing five test cells in which new propellants can be prepared and fired remotely.

The rocket fuels development is being studied by the company under auspices of Defense Department's Advanced Research Projects Agency (ARPA).

The new structures boast features believed unique in rocket fuels development and testing. Chief among these are a one-eyed, one-armed robot and complex remote testing system. Robot's single eye is a television camera that projects what it "sees" back to laboratory's central control room. Control system gives highly automated rocket fuel testing procedure.

Esso looks at engines

A mathematical model of the "ideal" automobile engine has been developed by Esso Research & Engineering. With the aid of a computer, Esso has used the model to see what would happen to an engine if its compression ratio were raised to 300 to 1. What they found: "We stopped at 300 to 1 compression ratio only as a matter of convenience. Actually, there appears to be no theoretical limit to the increase in efficiency of internal combustion engines . . . Although greater efficiency is mathematically possible, it will be a long time before such engines can actually be built. New fuels, materials and engineering know how will have to be developed."

Gas-synthesis operation

Operations problems and accomplishments of the Bureau of Mines' gas-synthesis demonstration plant, once operated at Louisiana, Mo., have been revealed in a new Interior Department technical report. The plant made gasoline, diesel fuel, other liquid fuels and chemicals from coal. The report in brief: A 39-day continous run produced 1,050 gallons of gasoline and 150 gallons of diesel fuel daily, plus other products. In 1953 the plant was shut down as an economy measure. The report also covers how gasification and gas-purification phases were integrated with synthesis and refining steps. For the entire report, free, ask for "Performance of Gas Synthesis Demonstration Plant for Producing Liquid Fuels From Coal," Publications Distribution Section, Bureau of Mines, 4800 Forbes Ave., Pittsburgh 13.

PRODUCTS

A world of plastic

"Plastic is fantastic" is a poetical note that could well have been the password at the recent Ninth National Plastics Exposition. Some predictions heard at the exposition: Total plastics output to increase four times to 25 billion pounds by 1975 . . . Conventional polyethylene to use up present capacity of 1.6 billion pounds by 1975 . . . Plastics in building materials to grow by a factor of 10 to $4.5 billion by 1970 . . . High-density polyethylene to jump from 170 to 233 million pounds this year.

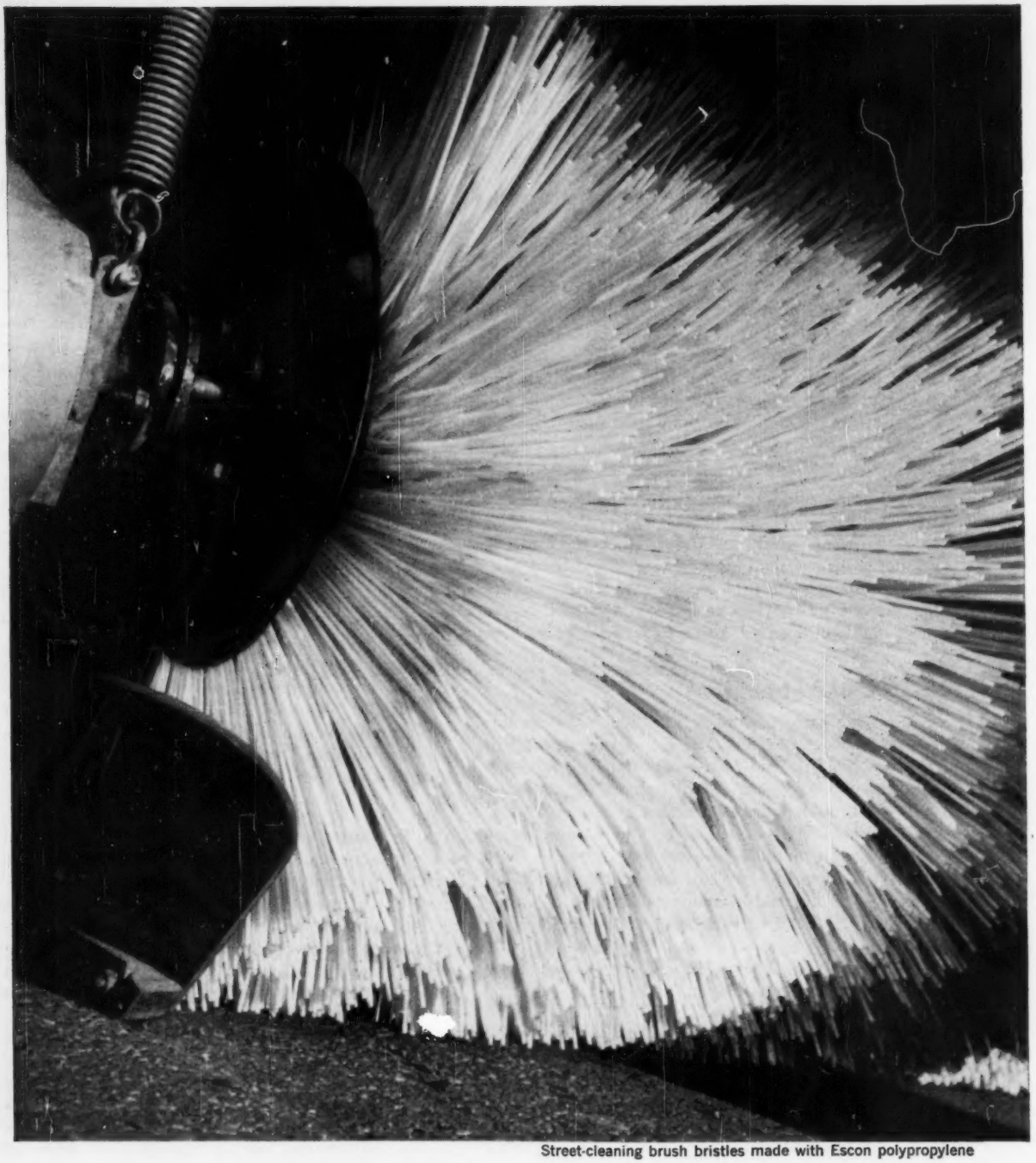
Meanwhile, Ford Motor spokesmen T. H. Risk and J. R. Forrester predict use of plastics in automobiles will double from present 25 pounds per car to 45 pounds by 1965. Reason: Continuous development of new and improved plastics, price reductions, and better handling of properties, fabrication techniques, and end-use properties.

The picture is just as bright in packaging, where the market is expected to double by 1965 to $800 million, says Monsanto Chemical spokesman. Here's the breakdown: 540 million pounds of flexible film, 75 percent polyethylene and polypropylene, with balance in vinyls, styrene, vinylidene chloride, polyvinyl alcohols and polyesters. Rigid packaging will account for 513 million pounds, to be used in blown bottles, dairy applications, produce baskets and trays. Miscellaneous class will take up 32 million pounds.

* **Synthetic natural rubber** keeps growing and gobbling up more of the market. With capacity for this new stereospecific synthetic rubber (polyisoprene and polybutadiene) slated to hit 370,000 tons by 1965, more pressure will be on rubber-tree growers to study production costs and use patterns. While overseas stereo capacity is scheduled to grow even more (500,000 tons) during the period, U.S. producers also face problems in technology and marketing. Interesting developments in Russia, where most overseas stereo capacity is to go, show they are giving up on conventional SBR synthetic rubber and staying with syn natural. Since they have failed in attempts to apply synthetic SBR, they have resorted to increased natural tree rubber consumption. Most of U.S.S.R.'s tire factories are set up to use natural, so synthetic natural plants will fit their needs.

General outlook: New stereospecific rubbers to eventually be sold profitably at well below the 20-cents-per-pound figure.

* **Stabilized formaldehyde** in a new form that defies winter temperatures and reduces tank truck order costs . . . has been made by Heyden Newport Chemical. This new formaldehyde can be stored for more than a month at 20-30° F below



Street-cleaning brush bristles made with Escon polypropylene

"Oil has many new frontiers to cross. In the researcher's test tubes and on the drawing boards we foresee a myriad of oil and chemical products still to be developed. New combinations of oil derivatives with materials outside of our oil stream widen the horizon."

—Leo D. Welch, Chairman of the Board

Standard Oil Company (New Jersey)

(WHOSE PRINCIPAL U. S. OPERATING AFFILIATE IS HUMBLE OIL & REFINING COMPANY)

the storage temperature of its equivalent unstabilized form.

User advantage: formaldehyde with greater resistance to polymerization induced by freezing atmospheric temperature, and runs less risk of shipments being made unusable.

* **Urethane elastomer demand,** which anticipated only a modest volume growth for the next few years, could see a sharp rise over the current market projections. Three primary factors offer evidence of the expected demand increase:

- Market acceptance of moldable and extrudable urethane elastomers will grow.
- Wider acceptance of elastomeric polyurethane fibers.
- Bright future for commercial production of polyurethane tires.

U.S. government statistics show 1960 demand for urethane elastomers was 6.8 million pounds. And just recently, the 1965 demand was predicted to be 35 million pounds.

* **Refrigeration** no longer dominates the the fluorinated hydrocarbon field as the top user. A big shift to aerosol products, to the tune of 55-60 percent, reverses the former pattern of refrigerants. Reason: the charge in a refrigerator lasts several years while fluorocarbons in the aerosol containers is usually consumed within a few months. Also, consumer demand for more and more aerosol-propelled personal products adds continuing unparallel growth factor.

* **Polymer use** promises to be extended by a new chemical technique. The method: Interfacial polycondensation (a formidable name, at that). The technique permits thin layers of polymers to be formed directly on fibers and sheet materials at ordinary temperatures. By contrast, some polymers have to be produced in the absence of air at high temperatures and high pressures, applied over long periods of time. One practical application of the new technique is in preparing nylon 6-10, which can be produced instantly with slight modifications of the basic process. Before, it would have taken several hours.

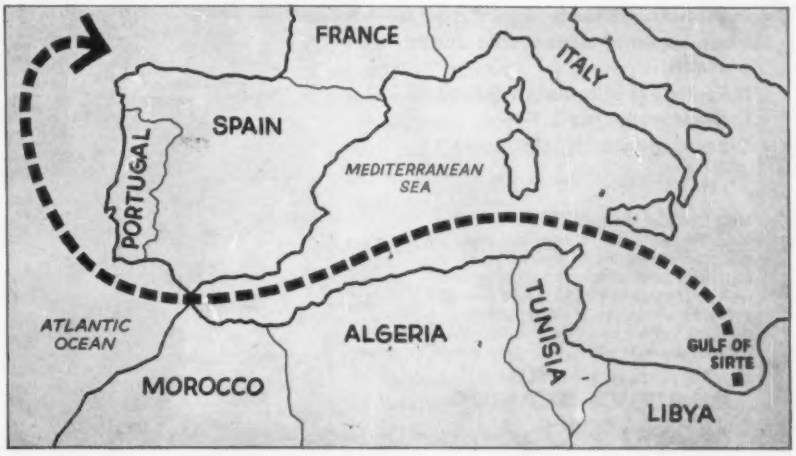
INTERNATIONAL

Liquid methane from Sahara

Terms have been set by Conch, the Gas Council of Great Britain and a group of French companies for the importation of Sahara Desert gas into the United Kingdom. The terms are being submitted to British authorities for approval. Conch is owned by Continental Oil, Royal Dutch Shell Group and Union Stockyard and Transit Co. of Chicago.

Until a short time ago, liquid methane had never been transported by sea because of intricate problems of shipping such a low-temperature cargo (in the range of —258° F). However, ocean transportation of LNG is now technically feasible with the completion of seven successful shipments made in the ship Methane Pioneer between the U.S. Gulf Coast and England.

The average daily boil-off for the seven trips was about 0.46 percent of the tank capacity. The minimum and maximum average daily boil-off for the trips was 0.425 percent and 0.492 percent respectively. At standstill at a dock, the equilibrium boil-off will run about 0.35 percent per day.



Crude for Ohio's Spanish refinery

Crude oil from Libya to Spain will take this route when shipping begins to The Ohio Oil Company's refinery to be built in northern Spain. Spanish tankers, loaded with Libyan crude, will travel about 2,500 miles. Ohio will begin drawing on Libyan discoveries by 1963.

Conch International Methane, Ltd., is now turning its attention toward transporting large volumes of LNG. New ships will probably have a capacity of about 167,000 barrels.

Meanwhile Britain's National Coal Board is attempting to dissuade Gas Council from importing liquid methane from Algeria to make municipal gas. Method: Ordering study of large-scale Lurgi coal gasification plants. Coal board, aware of gas industry's reduced dependence on coal, seeks to show economics of making municipal gas from coal rather than methane.

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- **Stem packing replaceable under pressure**
- **Monel stem eliminates galling of threads under load**
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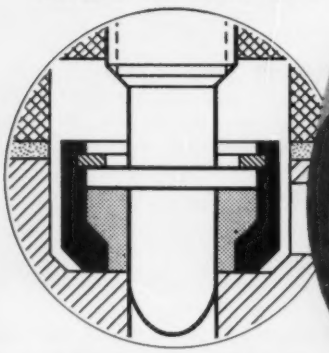

Swivel cage attached to free turning Monel stem acts as forming die when valve stem is screwed down. During closing operation, the stem forces the Teflon from cage to form a bubble-tight, Teflon-to-metal seal.

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ECONOMICS

Now it's NPRA

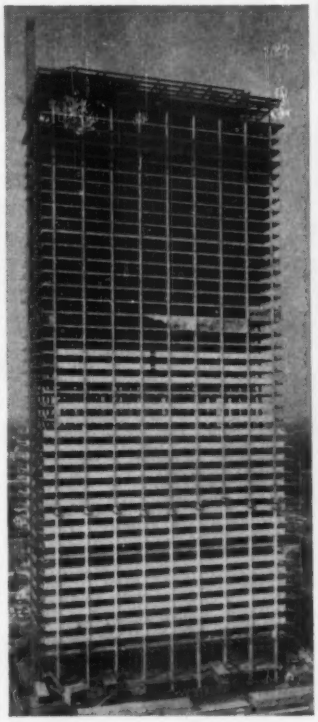
The merger between WPRA and NPA became official July 1. Letters were mailed to all members of both associations, inviting them to send a representative to the Organizational Meeting of the new Association, the National Petroleum Refiners Association. This meeting will be on June 28 at the Sheraton-Blackstone Hotel, Chicago. Its purpose: To adopt by-laws and elect officers for the period beginning July 1.

The first general meeting will be at the Hotel Traymore, Atlantic City, September 13-14-15.

Boom year

In 1960, petrochemical intermediates derived from crude petroleum and natural gas had another boom year. Over-all growth was about seven percent over 1959 with production exceeding 26 billion pounds. Aliphatic hydrocarbons lead with 18.6 billion pounds, and aromatics hit 7.5 billion.

Benzene from petroleum jumped 50 percent over 1959 production rates, landing at 7.5 billion pounds. Toluene slipped slightly to 1.7 billion pounds while xylene hit 1.8 billion in 1960. Ethylene soared to 5.5 billion pounds, followed closely by propane at 2.9 and propylene at 2.5 billion. Butadiene also had a good 1960 with production rising to 1.9 billion pounds.



In HPI capital

Another towering skyscraper being built in Houston is Humble Oil & Refining Company's headquarters building. Completion is set for mid-1962.

Merger in the mill

A consent decree in the U.S. government's civil antitrust suit against Jersey Standard and Standard-Kentucky has opened the door to a merger of Kentucky Standard into Standard-California. Consent decree stipulations say: Standard of Kentucky will not buy any of its product requirements from Jersey in 11 southern states after July 1, 1966: Standard-Kentucky and Stancal agree to buy at least 40 percent of their requirements from independent refiners. But, both won't buy more than 15 percent from any single independent until July 1, 1976.

Jersey said it was "surprised" at the decree, and added that a stipulation on Kentucky's future supply provides that "the contract under which competition for this supplier was not foreclosed forever is being supplanted by an arrangement under which it ultimately will be."

Control standards

Standards work in numerical control of machine tools and process control computers will begin later this year, pending approval of new project by ASA. As suggested by the Electronic Industries Association, project would concern computers and related equipments in two principal application areas: industrial process control and machine tool numerical control.

Specific tasks suggested by EIA:

- In industrial process control, ways for specifying analog device sensitivity
- In machine tool numerical control, codes for feeding information to machines
- In data transmission, work concerned with characteristics of the interface between transmission medium and computer.
- In input-output, work concerned with measurement and description of media characteristics, such as cards and tape.

GOVERNMENT

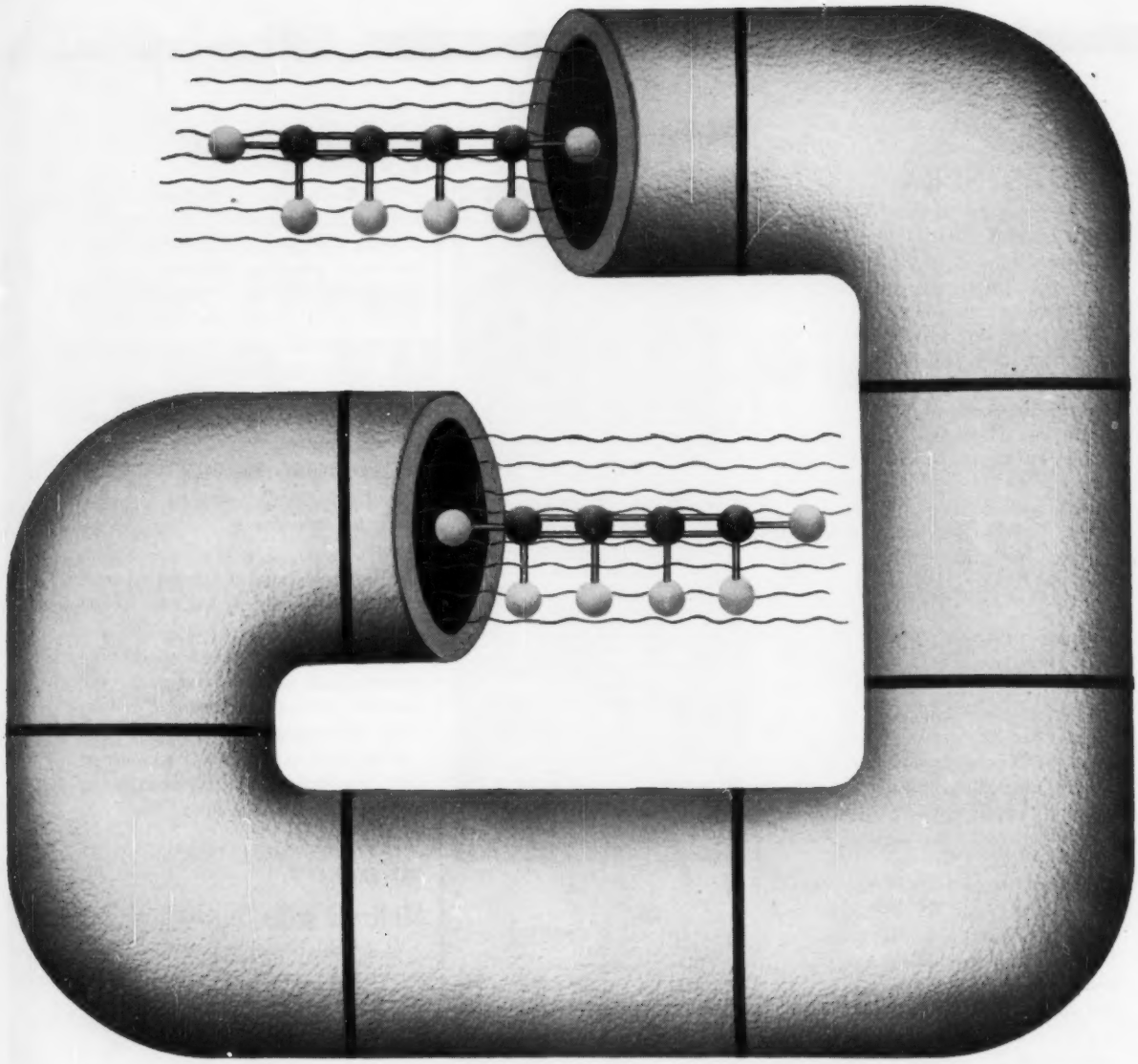
Helium gets boost

U.S. Senate Appropriation Committee's approved 1962 fiscal budget for the Interior Department went $40 million over Department's own budget estimates and $70 million over House's approval. Increases include those given helium program, and Oil Import Administration. Helium received substantial boost when the committee authorized it to buy up to $60 million per year of helium. Also, Office of Helium Activity got committee approval to borrow $15 million for coming year.

OIA gets the blame

Crown Central Petroleum has blamed the U.S. government's oil import program for a $2-million-per-year loss in gross profits and has asked for allocation increases to the Oil Import Appeals Board. The company's present 3,490-bpd allocation is less than 10 percent of its refinery capacity. Crown officials claim that 20,000 bpd is needed for them to stay competitive.

for more about what's happening in HPI, turn to Page 265



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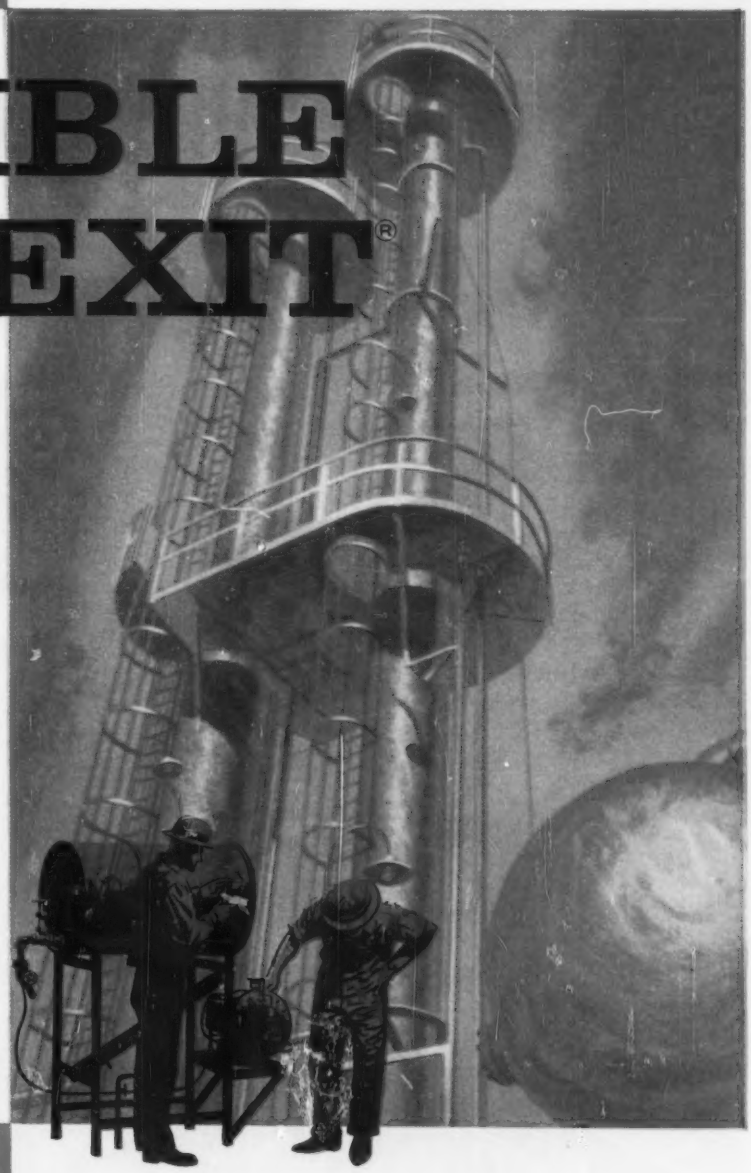

* *Ten years of measurements* in refineries and gas plants prove its high efficiency and economy. For as little as 50¢ per thousand barrels of throughput, Humble COREXIT prevents internal corrosion in pipe still overhead, distillation towers, vapor recovery systems and other refining units. Equipment life is extended, you make longer runs between turn-arounds, and down time is reduced. *COREXIT makes important savings in every refinery and gas plant where it is used.* For complete information on technical services and COREXIT formulations to meet your specific requirements, see your Humble salesman or contact Humble Oil & Refining Company, Houston, Texas.

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For more data on advertised products, use cards, last page.

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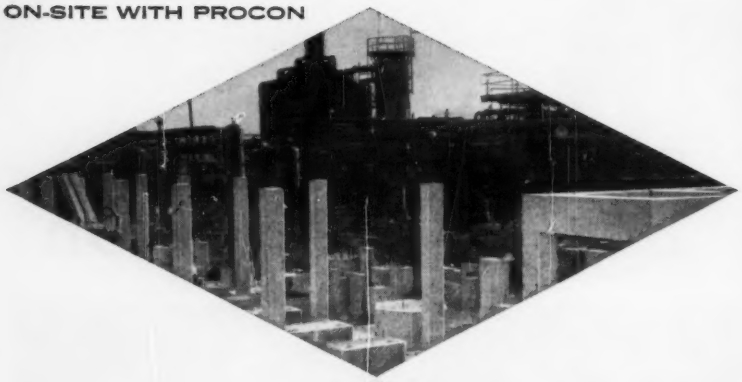

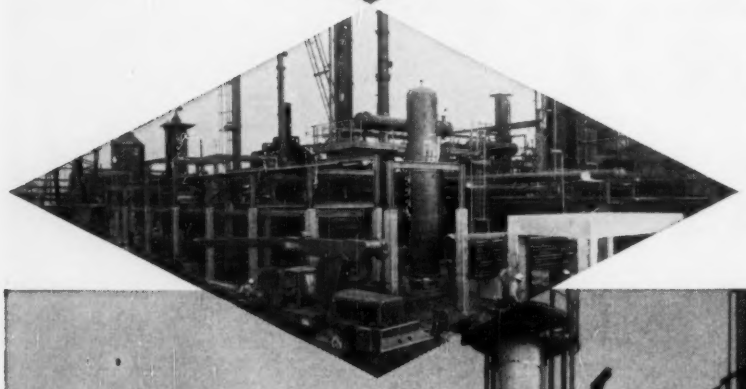

Procon-built Hydeal unit on-stream in 95 days!

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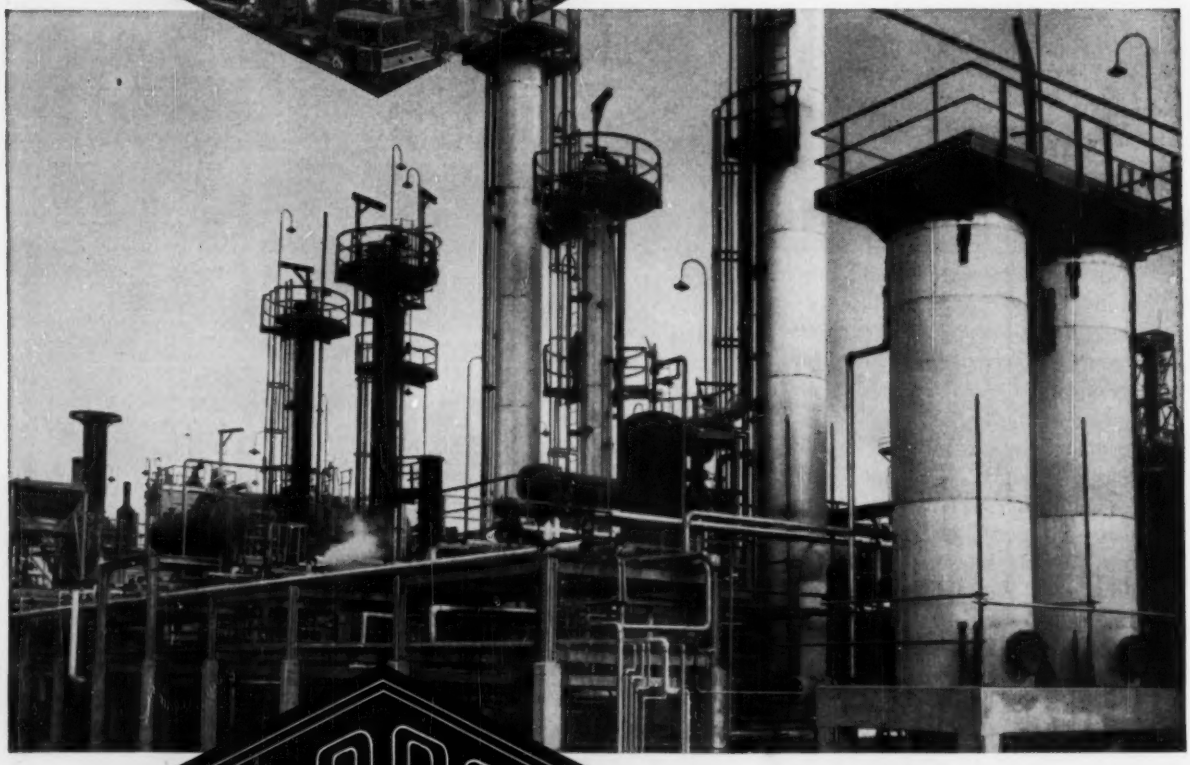

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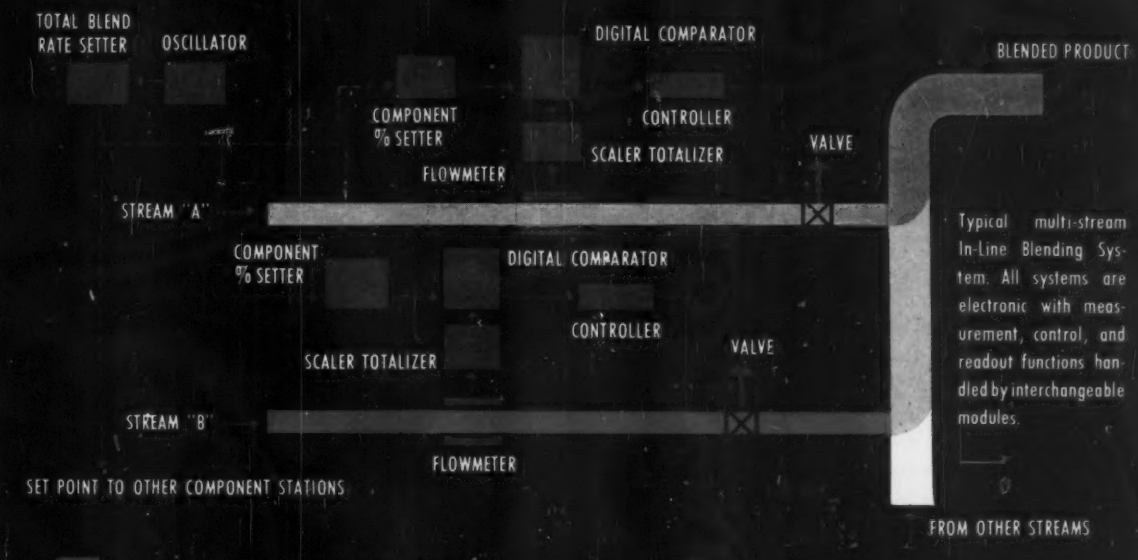
Result: fast, precise, flexible systems that enable you to control mixing or blending from feed lines to point-of-use — product pipelines, tankers, whatever. You eliminate wasteful batching operations in between. Many types of systems are available, including the blending of two or more streams for petroleum, chemical, food, or other products of processing industries.

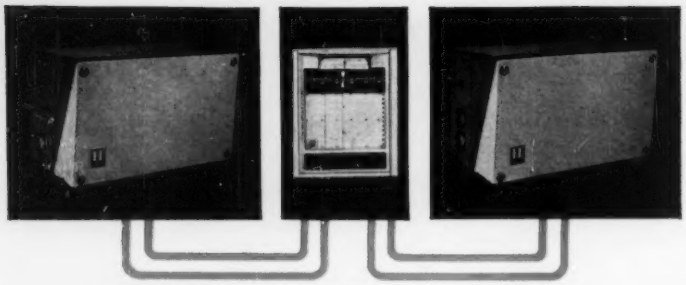
A description of your interests will bring you complete technical data. And, let us know if you would like to see a typical system in operation here at the plant . . . Fischer & Porter Company, 971 County Line Rd., Warminster, Pa. In Canada, write Fischer & Porter (Canada) Ltd., 2700 Jane St., Toronto.



Typical multi-stream In-Line Blending System. All systems are electronic with measurement, control, and readout functions handled by interchangeable modules.

FP FISCHER & PORTER COMPANY

A world-wide Instrument Company with plants in Australia, England, France, Germany, Holland, Mexico, and the United States.



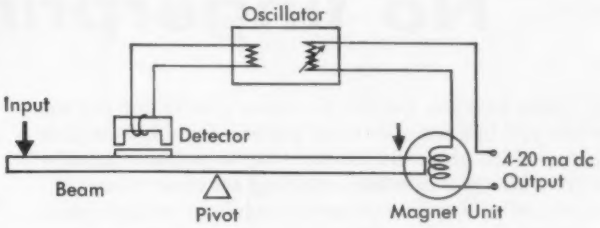
***ElectriK Tel-O-Set*—the true 2-wire system**

Care and feedback of delicate inputs

Delicate inputs thrive on the tender care of *ElectriK Tel-O-Set's force-balance feedback system*. This system, used as the basic circuit in *Tel-O-Set* transmitters, receivers, controllers, and other instruments, has proved itself in thousands of installations in the last five years. The force-balance feedback circuit increases the accuracy and dynamic response of the system by decreasing hysteresis effects and sensitivity to changes in ambient conditions.

Observe: (1) input force (from bellows, Bourdon tube, or displacement linkage) deflects pivoted beam; (2) air-gap in ferrite detector increases, (3) producing a change in inductance in oscillator circuit; (4) a portion of output current is fed back into magnet unit, producing a force on beam which is equal and opposite to input force; feedback balances beam. Full scale motion is only one-thousandth of an inch.

The advanced control engineering seen in force-balance feedback is carried through the entire *ElectriK Tel-O-Set* System. Specifically, there's no external power required at any field-mounted *Tel-O-Set* instrument. Line power connection is made only at the receiver. Two-wire d-c transmission eliminates shielding problems. The 4-20 milliamp signal range of the system gives a live zero and permits the use of the most reliable transistors available. The d-c signals



can be fed into data handling systems and millivolt-actuated instruments . . . can be easily transduced to a standard 3-15 psi pneumatic signal to operate existing pneumatic systems.

Take a new look at your control applications with the *ElectriK Tel-O-Set* System in mind! Get complete technical data from your local Honeywell field engineer. Call him today . . . he's as near as your phone. MINNEAPOLIS-HONEYWELL, 21 Penn Street, Fall River, Massachusetts.

Honeywell

First in Control

SINCE 1885

For more data on advertised products, use cards, last page.

No fingerprints allowed

To make sure you get the premium quality you pay for when you buy stainless steel pressure tubing, we give it the white glove treatment. Our inspectors actually wear white gloves while working on these tubes. It's typical of steps taken to assure excellent surface finish and high internal quality.

You're assured of highest value when you buy Timken® stainless steel pressure tubes because:

Special techniques, unique in the industry keep physical properties and chemical composition at maximum uniformity.

You can select from a wide variety of sizes and analyses of tubing—many available nowhere else—to suit your needs.

You can call on the services of acknowledged experts in the field of stainless steel pressure tubing.

Call in Timken Company metallurgists to get the most for your money. The Timken Roller Bearing Company, Steel and Tube Division, Canton 6, Ohio. Cable: "TIMROSCO". Makers of Tapered Roller Bearings, Fine Alloy Steel and Removable Rock Bits.

TIMKEN®
***Fine Alloy* STEEL**

TIMKEN ALLOY STEEL AND SEAMLESS STEEL TUBING ARE AVAILABLE FROM STEEL SERVICE CENTERS IN 44 CITIES IN THE UNITED STATES

is Creep affecting your high-temperature operations?

The container for heavy liquids at high temperatures, shown above, is a striking example of creep failure. Note the "necking down" below the supporting lip and the bulging of the container near the bottom.

Creep is a time-dependent plastic flow occurring under stress, usually at elevated temperatures. In a creep-rupture test, three distinct stages are observed. The initial stage has a relatively high, but steadily decreasing creep rate. In the second stage, the rate is constant and provides the minimum rate of the entire test. The creep rate in the third stage increases steadily to rupture.

Creep is but one of five major failure mechanisms that can affect your high-temperature operations. The others are oxidation, thermal fatigue, carburization and phase change. Any one or a combination of these mechanisms can result in reduced service, frequent repair or costly replacement of your high-temperature equipment.

You should, therefore, select suppliers who are aware of these failure mechanisms, so that they can assist you in selecting a material and a design that will insure longer life and more dependable service.

Here at Electro-Alloys and at our Research Center in Mahwah, New Jersey, we have studied in detail the significance of all of the failure mechanisms as they relate to metal composition, design, service conditions and manufacture of heat-resistant alloy castings.

Our Research Center, for example, pioneered the establishment of a creep laboratory and has played a major role in defining the variables affecting validity and precision in creep-rupture testing.

From these studies, we have developed new high alloys for use in heat-resistant castings. But more important, we have become better qualified to assist you in getting maximum life and reliable service from high-temperature equipment.

Our local sales representative will be happy to discuss any of your problems concerning heat-resistant applications. Please feel free to call on him.

AMERICAN Brake Shoe COMPANY

ELECTRO-ALLOYS DIVISION · Elyria, Ohio

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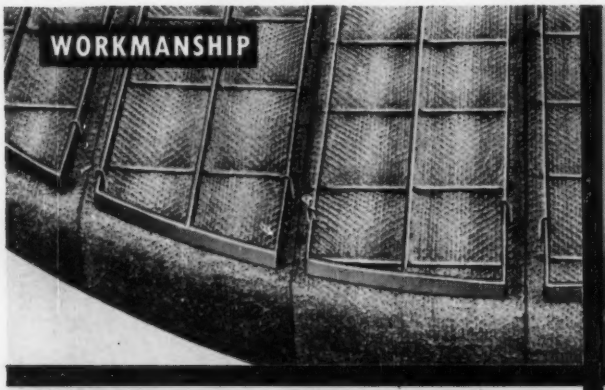
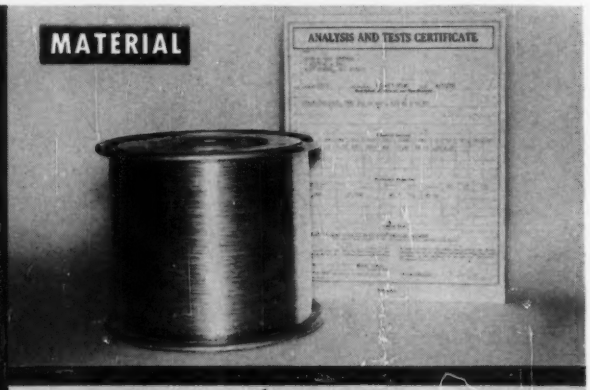
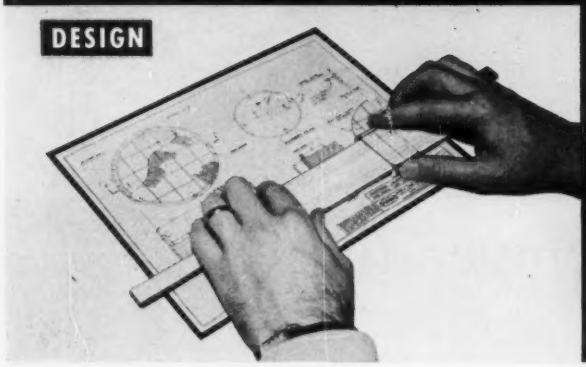
SPECIFY **YORK DEMISTERS®**

FOR THE BEST IN:







FOR IMPROVED PERFORMANCE IN PROCESS EQUIPMENT — IN DISTILLATION COLUMNS, ABSORBERS, EVAPORATORS, SCRUBBERS, RECEIVERS, SEPARATOR DRUMS, STEAM DRUMS, ETC. — FOR THE EFFICIENT SEPARATION OF MIST AND ENTRAINED LIQUIDS FROM STEAM, AIR OR ANY PROCESS GAS OR VAPOR.

The best is what you get from York, because York furnishes only top quality equipment, and has the know-how and experience. Over 10,000 successful installations prove this.

Excellent workmanship is required to get the best performance. The best quality materials give added resistance to corrosion. Proper design means the lowest cost, most efficient installation.

You get all these from York, and delivery when you need it.

Depending upon your application, the Demister will recover valuable liquid products, provide clean dry gas, prevent air or steam pollution, reduce downstream corrosion, provide dry steam, protect compressors against damage by liquid entrainment and/or increase throughput capacity.

THE BEST COSTS LESS IN THE LONG RUN!

Send information on your operations to receive a *carefully* considered recommendation. ***For more details request Bulletin #21.***

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SPECIALISTS IN FLUIDS SEPARATIONS

SIGNS OF THE TIMES

We've designed these little billboards so that they can be easily pushed from the page and assembled for desk-top use. Why not put them together—perhaps their humor will help brighten your day? And remember—Wolverine condenser tube products rate headlines because they do things—the kind of things that make for increased heat transfer efficiency and economy.

**PUSH OUT PIECES...
SET BILLBOARD IN SLOTS**

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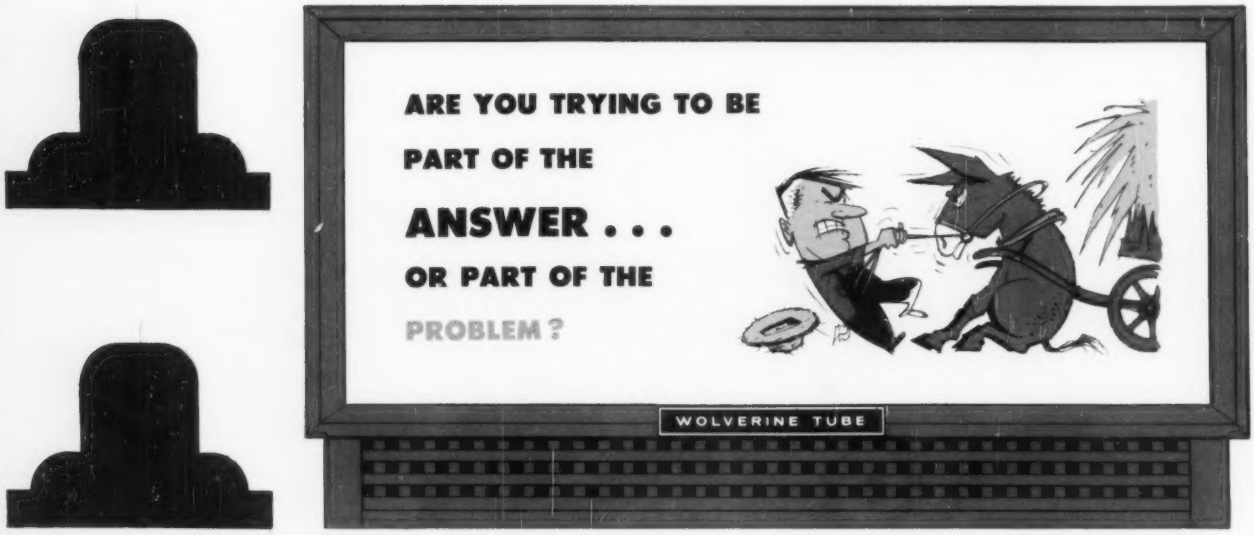
Calumet & Hecla, Inc.
DEPT. O, 17236 SOUTHFIELD RD., ALLEN PARK, MICH.
TUBEMANSHIP in Copper—Copper Alloys—Aluminum—Special Metals

WE'VE LEFT ONE BLANK FOR YOU

fill in your favorite saying and mail it to Wolverine Tube ...help us keep our campaign going



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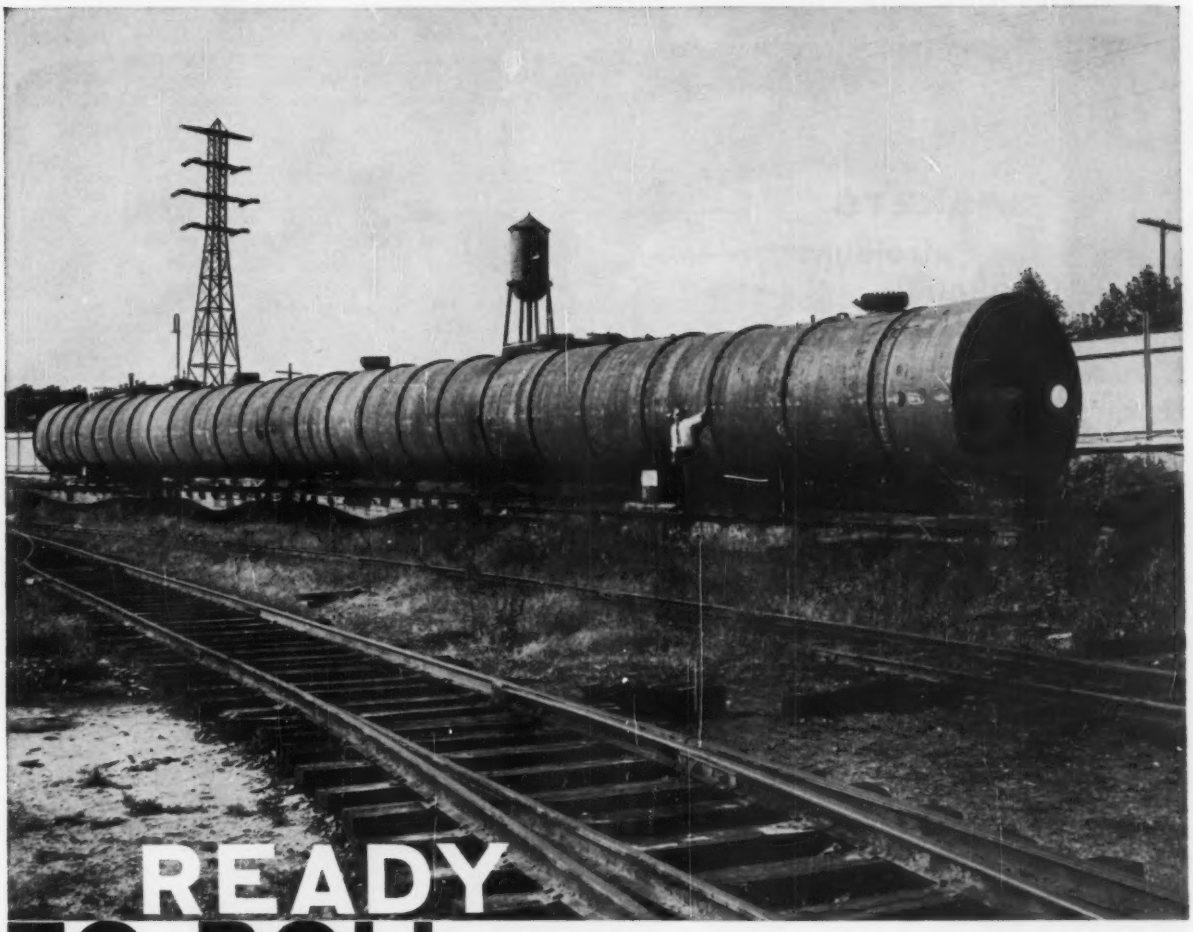

READY TO ROLL . . .

Another big tower for industry

Building and delivering big items like the 165-foot-long fractionating tower pictured here is routine performance at Sun Ship. Two towers, each weighing 135 tons and identical with that shown above, were constructed for a petrochemical plant for processing petroleum gases. They were shipped on 9 flatcars. Railroad officials said it was one of the largest shipments ever moved by rail. Because of its length the shipment had to travel a circuitous rail route.

Whether it's a massive fractionating tower or intricate equipment, your requirements will be met with exacting precision and your product delivered on schedule by rail or water from our tidewater plant.

Sun Ship's modern fabricating and engineering services put these advantages at your fingertips. For full information, call or write our Sales Engineering Department.

Sun

SHIPBUILDING & DRY DOCK COMPANY

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For more data on advertised products, use cards, last page.

GASKETS
for Petroleum Refining

GARLOCK . . . one reliable source to meet all of your gasketing needs. Whatever your requirements, you'll find a high-quality Garlock material exactly suited to the job. For example: **Compressed asbestos gasketing —either in sheet or custom-cut to your specifications:**

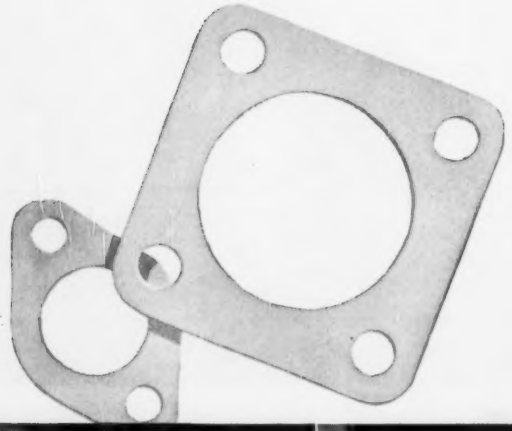
- For hot oil service to 700°F—specify **GARLOCK 7021** Compressed Asbestos
- For hazardous liquids and solvents, such as gasoline, naphtha and benzine at temperatures to 300°F —specify **GARLOCK 7228** Compressed White Asbestos with Neoprene binder
- For hot and cold mineral acids, either alone or in conjunction with oils or organic solvents—specify **GARLOCK 7705** Compressed Blue Asbestos
- For gasketing at temperatures to 700°F against steam, gas, air and other services not involving extremely hot oil, organic solvents or strong mineral acids—specify **GARLOCK 900** Compressed White Asbestos
- For strong solvents such as benzol, toluol and other aromatic and chlorinated types—specify **GARLOCK 8748** Compressed White Asbestos with Nitrile binder

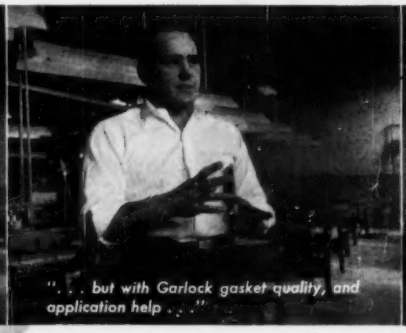
Rubber gasketing in sheet form:

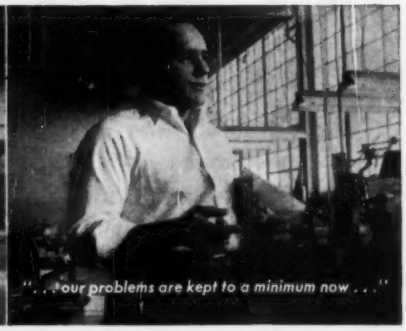
- For non-aromatic petroleum, fatty oils or solvents at temperatures to 300°F—specify **GARLOCK 7797** Neoprene sheet with 80 durometer hardness (other styles from 40 to 90 durometer hardness)
- For oils and solvents at temperatures to 300°F—specify **GARLOCK 8459** Nitrile sheet with 80 durometer hardness (other styles from 50 to 90 durometer hardness)

Rubber Diaphragm Gasketing—either in sheet, cut-to-order, or in molded diaphragm:

- For wet natural gas, gasoline or oils at medium or high pressure—specify **GARLOCK 7992** Neoprene Rubber Diaphragm sheet
- For hot or cold air, high aniline point oils and many fire resistant fluids, such as Cellulube,* at temperatures to 300°F—specify **GARLOCK 9296** Silicone—Dacron† Diaphragm sheet







For prompt delivery, complete gasket cutting facilities are available in Palmyra, N. Y., Philadelphia, Pa., Houston, Texas, San Francisco (Burlingame), Calif., and Hamilton, Ontario, Canada. Get details by contacting the nearest of the 26 Garlock sales offices and warehouses throughout the U. S. and Canada. Or, write Garlock Inc., Palmyra, N. Y.

Canadian Div.: Garlock of Canada Ltd. **Plastics Div.:** United States Gasket Company. **Order from the complete line** of quality Garlock products . . . Packings, Gaskets, Seals, Molded and Extruded Rubber, Plastic Stock and Parts

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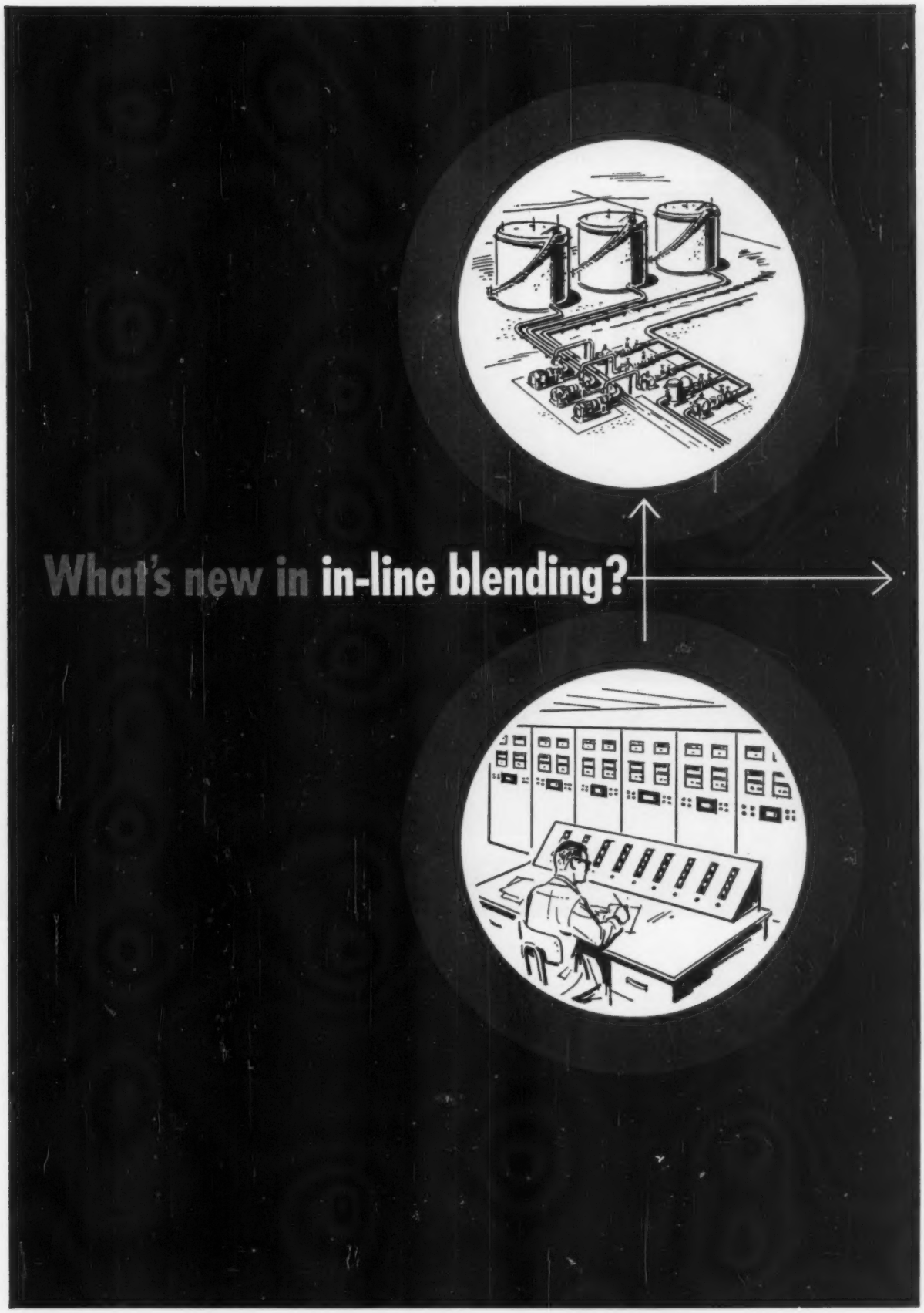
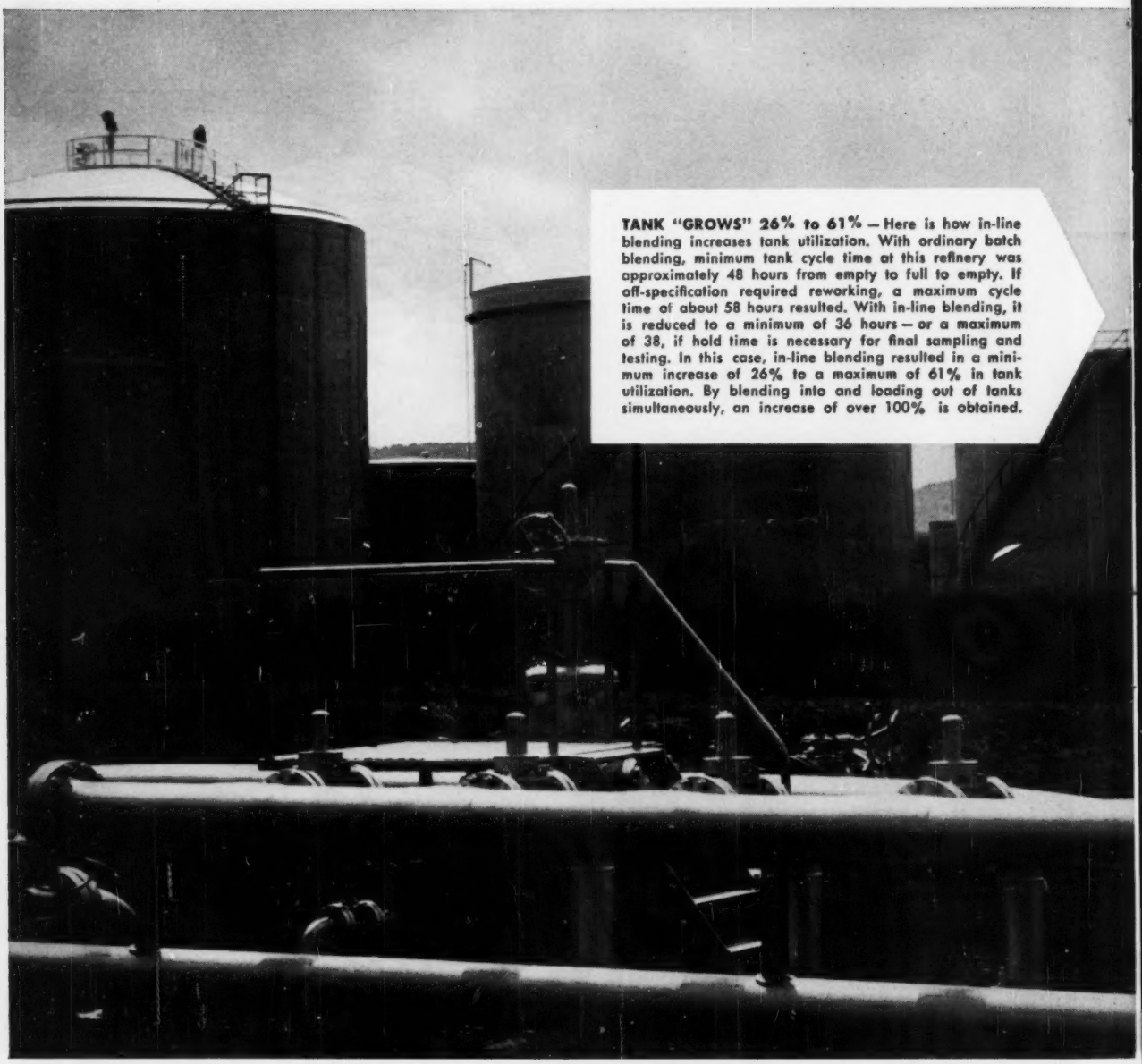
GARLOCK


What's new in in-line blending?



TANK "GROWS" 26% to 61% — Here is how in-line blending increases tank utilization. With ordinary batch blending, minimum tank cycle time at this refinery was approximately 48 hours from empty to full to empty. If off-specification required reworking, a maximum cycle time of about 58 hours resulted. With in-line blending, it is reduced to a minimum of 36 hours — or a maximum of 38, if hold time is necessary for final sampling and testing. In this case, in-line blending resulted in a minimum increase of 26% to a maximum of 61% in tank utilization. By blending into and loading out of tanks simultaneously, an increase of over 100% is obtained.

New In-Line Blending Developments Save Dollars at Existing Refineries

By B. G. Crane

THE ARRIVAL OF ELECTRONICS on the scene has dramatically changed the outlook of in-line blending in the oil industry.

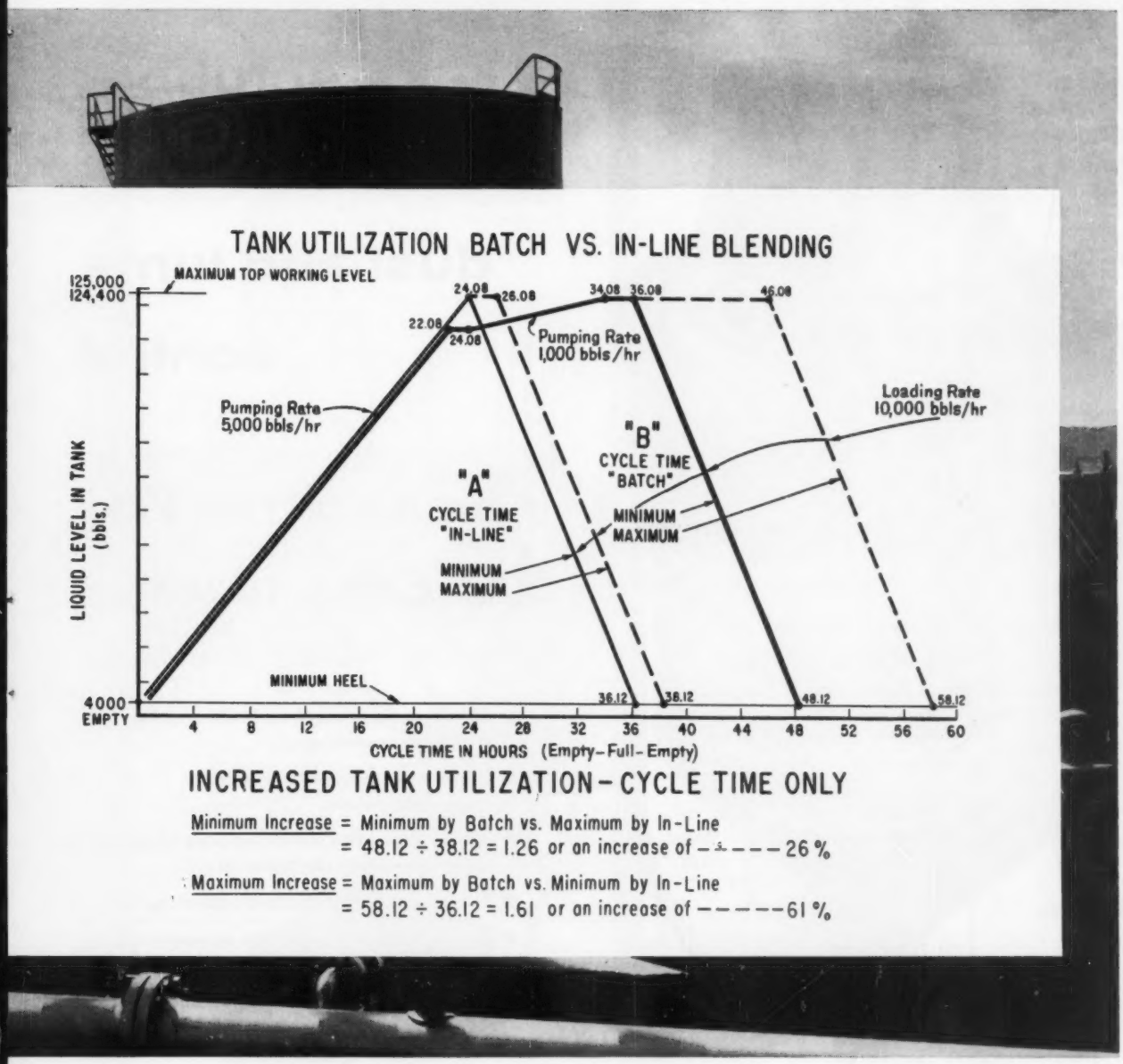
Until now, you had to make such big changes in field piping that most existing refineries could not justify the expense. In-line blending has been adopted at most new refineries, almost as a matter of course, but operators of older plants have had to stand wishfully by.

Now it is no longer necessary to make such extensive piping changes. With electronic control equipment and transmission of signals as digital pulses, you do not have to pipe gasoline components to a central meter station adjacent to a control room.

Other Savings

Not only do you save piping costs, but there are also definite savings in the size, location and installation costs of the control room and control equipment.

For more data on advertised products, use cards, last page.



Constant-Concentration Loop

Another new development is the constant-concentration loop for adding lead antiknock compounds. Often, lead blending facilities are far from the desired location of the gasoline blend header, necessitating relocation of the unit. The so-called "constant-concentration TEL loop" eliminates any need to move the blending plant or build a new one closer to the header.

At one refinery, this constant-concentration loop will save $50,000 in construction costs.

Greater Tank Utilization

Since in-line blending can increase tank utilization as much as 100%, it may justify a closer look at many existing refinery locations – particularly where tankage is becoming inadequate or is in need of replacement.

In-line blending speeds up blending time, permits you to blend closer to ultimate specifications with no "quality giveaway", and gives operating flexibility never before possible.

You save in many other ways, too. No reblending. Less loss of light ends. Lower labor cost. Lower inventories of additives. Increased safety. These are all factors to consider when you compare in-line blending to your present batch or partially continuous method.

B. G. CRANE is Manager of Operations for Du Pont's Petroleum Chemicals Division. He has been active in the field of gasoline blending with antiknocks and other additives for nearly 30 years, and has been an active participant in the development of in-line blending techniques. He recently spoke on this subject at a W.P.R.A. meeting, and reprints of his talk are available. If you would like a copy, contact your Petroleum Chemicals Division representative.

LEAD ANTIKNOCK COMPOUNDS
AND OTHER PETROLEUM ADDITIVES

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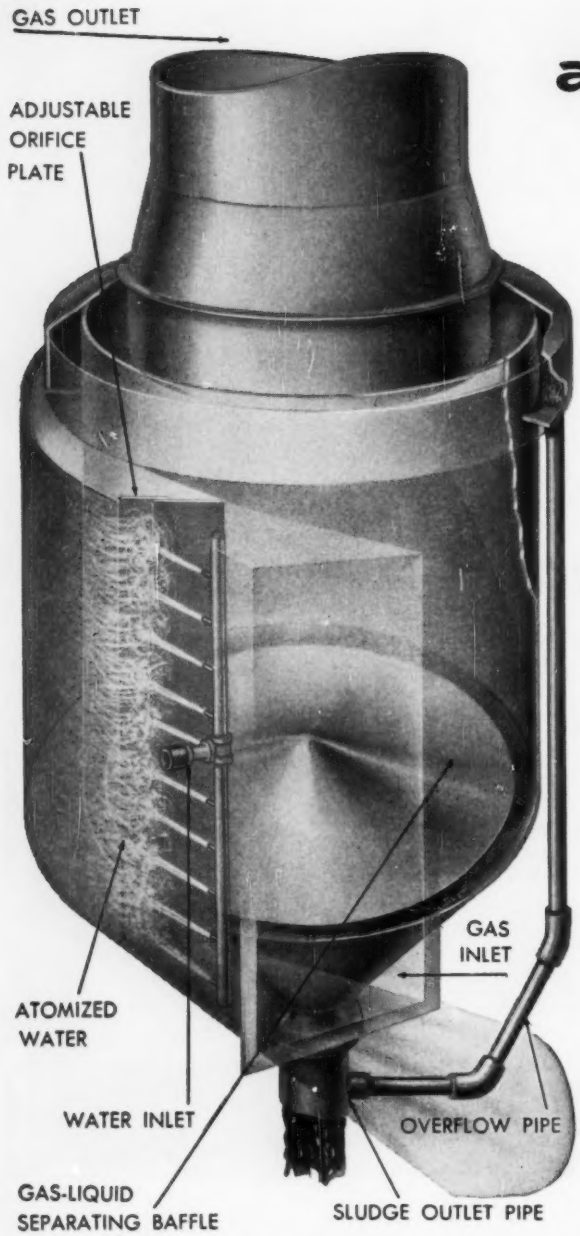
BETTER THINGS FOR BETTER LIVING . . . THROUGH CHEMISTRY



a NEW scrubber for ultra-efficient dust and fume control

THE DUCON TYPE VO Oriclone® SCRUBBER

- 50% less space requirements than other high energy scrubbers.
- Higher operating efficiency at lower horsepower.
- Adjustable orifice maintains peak efficiency when operating conditions vary.
- Economical in first cost and operating cost.
- Simplicity of design permits economical alloy construction or acid brick lining.
- 99% efficiency below 2 micron and in sub-micron range.

The Ducon Type VO Oriclone Scrubber—the only high energy scrubber with an adjustable orifice—is the most effective and most economical dust and fume collector for a wide range of industrial applications, including recovery of catalyst dust, cupola dust and fumes, acid mists, tar fog and many others.

The Oriclone Scrubber is a completely integrated unit that performs the entire separation cycle. No subsequent collector is needed.

Send today for detailed information on Oriclone.

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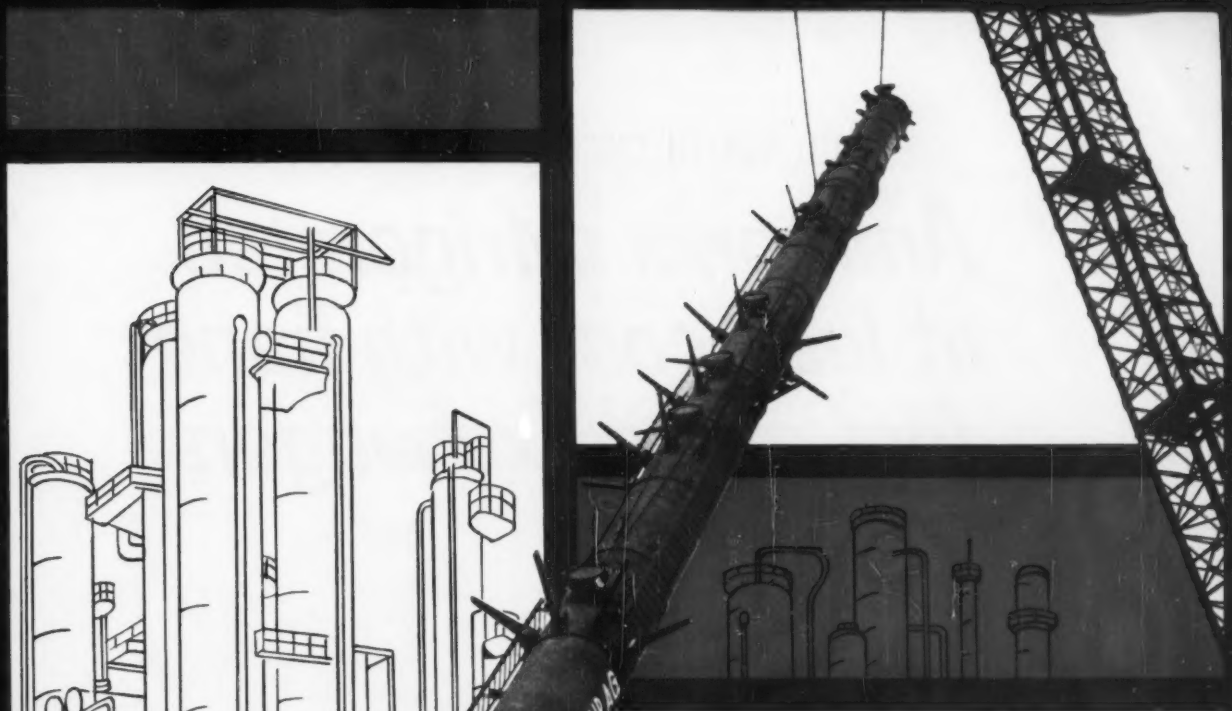
CYCLONES • CENTRIFUGAL WASH COLLECTORS • TUBULAR CLOTH FILTERS • DUST VALVES



Our program for the petrochemical industry

Varying according to the specific requirements we supply the following products made of standard and special steels as well as of clad plates:

Containers and apparatus, such as:
coke towers · vacuum towers
fractionating columns · stabilizers · reactors
evaporators · heat exchangers · coolers
high pressure vessels
as strip-wound pressure vessels
or solid vessels
transport vessels
storage vessels for liquids and gases
spherical caps and segments, hot-pressed
for spherical containers
heads, hot-pressed · flanged and flad heads
spherically dished heads, ellipsoidal heads
shells, bent and welded
tubular coils and tubular systems
tube bends and specials
tubes for distillation, refinery and cracking plant etc.
flanges · fittings with API-threads
wide flat steel · plates, sections and bars
made of unalloyed and low-alloy materials
plates, medium plates and sheets, sections and bars as well as electrodes
made of our SICROMAL and RHEINROHR special steels
clad plates

PHOENIX-RHEINROHR AG
VEREINIGTE HÜTTEN- UND RÖHRENWERKE DÜSSELDORF
GERMANY

MID-SOUTH CHEMICAL REPORTS...

Ammonia refrigerated at less cost with Trane Air-Cooled Exchangers

Air-cooled condensers eliminate costly water supply, maintenance costs.

The trend toward the use of refrigerated vessels—rather than full pressure—for the processing and storage of liquefied gases is indicated by this new installation.

This Mid-South chemical plant at North Pekin, Illinois uses five TRANE Fluid Coolers —four 15-ton "holding" refrigeration condensers and one 65-ton "filling" refrigeration condenser.

Lower Construction Costs

Refrigerated tanks at Mid-South Chemical are designed for lower pressures and constant maintenance of product temperatures. The tanks, by Chicago Bridge & Iron, are built of lighter steel. And savings on steel were much greater than the cost of insulation and refrigerating equipment. TRANE units helped make these savings possible.

Lower Operating Costs

Another reason TRANE air coolers were selected by Mid-South Chemical was to eliminate the high and continuing costs of operating water-cooled equipment. If water-cooled equipment were used, 120 GPM of treated water would be required, frequent cleaning of the shell-and-tube condensers would be necessary, and a cooling tower would have had to be built.

Lower Maintenance Costs

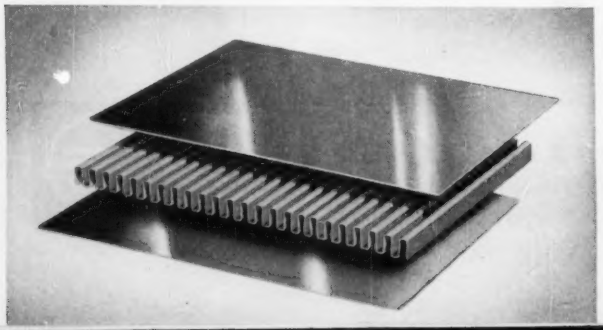
TRANE Fluid Coolers normally need only periodic cleaning of the fin-tube surface. No need for costly maintenance crews . . . spare parts . . . special maintenance facilities and equipment to combat scaling, fouling and corrosion of water-cooled equipment.

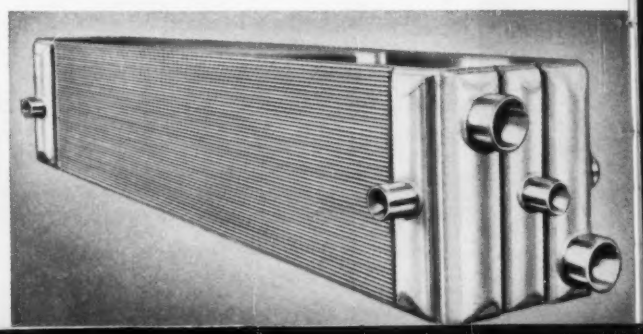
WANT MORE FACTS?... For additional information on any heat transfer problem see your nearby TRANE Sales Office—or write direct to TRANE, La Crosse, Wisconsin.

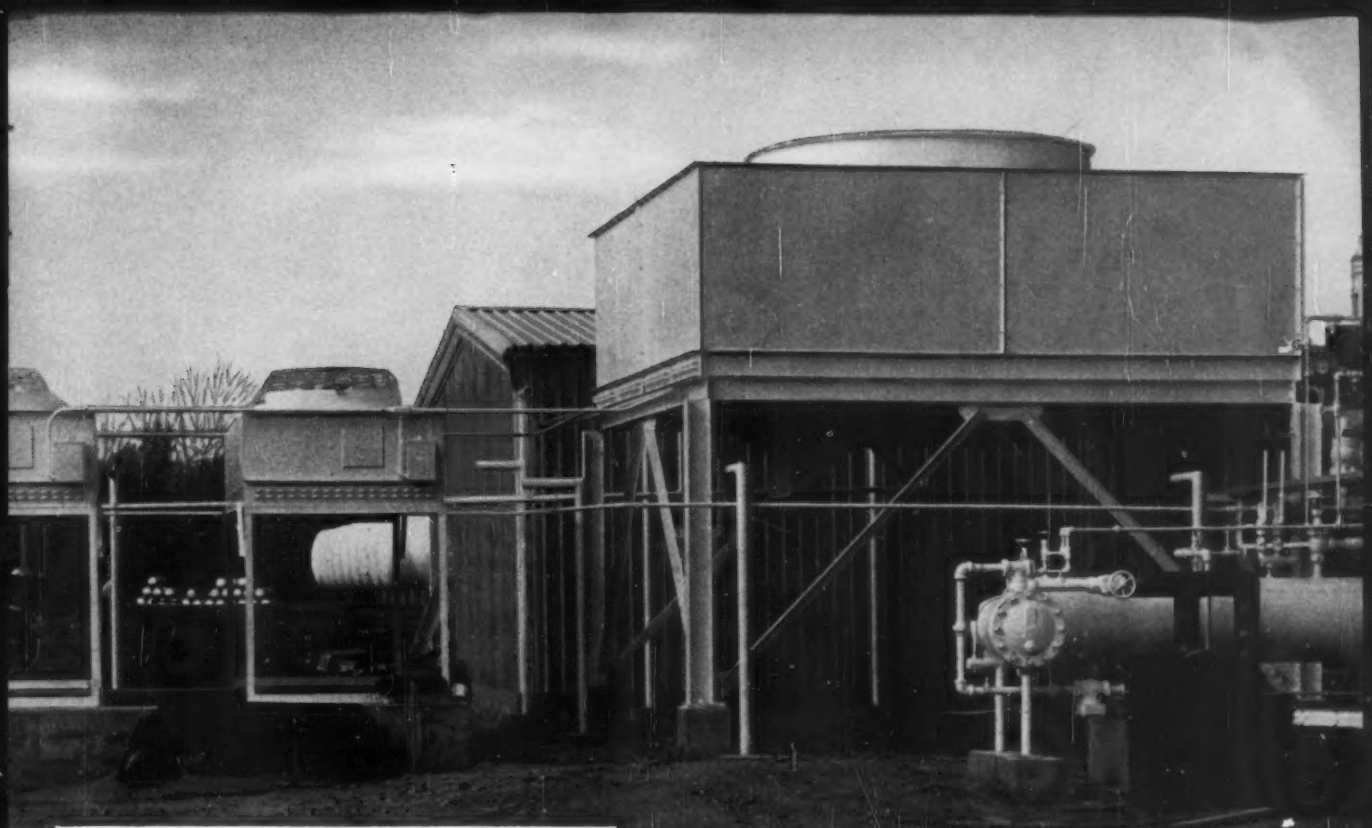
TRANE Brazed Aluminum Heat Exchangers—for low temperature processing of gases and liquids

Lightweight, compact TRANE Brazed Aluminum consists of corrugated aluminum sheets brazed together to form a stack of layers which form individual passages for the flow of fluids or gases. Provides up to *nine times* the surface per cubic foot of shell-and-tube exchangers! TRANE Brazed Aluminum Exchangers pack up to 450 sq. ft. of heat transfer surface in one cu. ft.

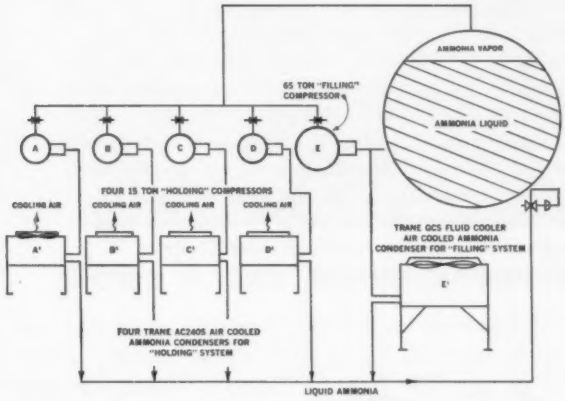
Headered for 5-stream operation, this TRANE Brazed Aluminum Heat Exchanger can handle as many as five fluids simultaneously. Units are available for either cross-flow or counter-flow operation. Surface can be fabricated in a wide variety of shapes and sizes to meet all types of requirements.







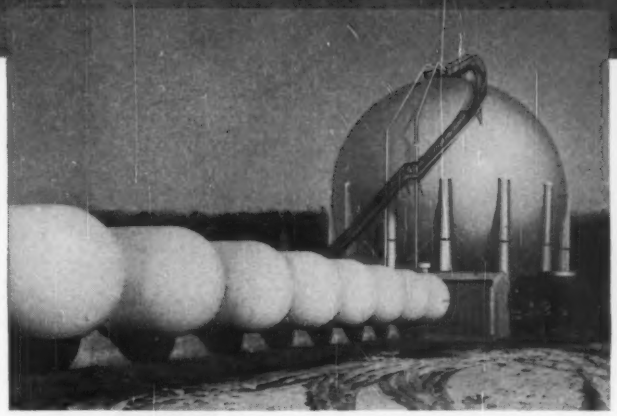
TRANE Fluid Coolers. Shown here are three of the four TRANE Fluid Coolers used in Mid-South Chemical's North Pekin operation. TRANE Fluid Coolers have a life expectancy of 15 to 20 years—compared with 7 to 10 years for cooling towers. TRANE has had over 30 years of heat transfer experience.



Basics of Mid-South Chemical's procedure

FILLING—Liquid ammonia at ambient air temperatures is transferred from conventional high pressure storage to Hortonsphere. During transfer a portion of this liquid flashes to vapor. This vapor is compressed, condensed in TRANE Fluid Coolers and returned to the Hortonsphere.

HOLDING—A portion of the liquid ammonia stored at 36°F in the Hortonsphere evaporates to vapor due to solar heat pickup. This vapor is re-compressed, and condensed in TRANE Fluid Coolers—and the liquid is returned to storage.



Huge storage capacity is provided by the Hortonsphere. This unit has a 28,000-barrel capacity—equivalent to about 44 blimps like those in foreground.

For any air condition, turn to

TRANE

Manufacturing Engineers of Air Conditioning, Heating, Ventilating and Heat Transfer Equipment

THE TRANE COMPANY, LA CROSSE, WIS. • SCRANTON MFG. PLANT, SCRANTON, PA. • CLARKSVILLE MFG. PLANT, CLARKSVILLE, TENN. • SALT LAKE MFG. PLANT, SALT LAKE CITY, UTAH • TRANE COMPANY OF CANADA, LIMITED, TORONTO • 101 U.S. AND 20 CANADIAN OFFICES.

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Conveniently located in Portland, Oregon, American offers rapid and economical service to a growing Petrochemical Industry in the West. For your immediate needs our entire Sales, Engineering and Production personnel are available to serve you. Short-haul transportation distances insure units arriving quickly to give you maximum production time.

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SEATTLE: ADams 2-1336

Photographed at American Oil Co., (Wood River, Ill., Refinery)

New! A far more versatile hydrogen-treating catalyst

Are you still using conventional cobalt-molybdenum desulfurization catalysts on feedstocks high in nitrogen and polyaromatics? Then it will pay you (in production and profits) to investigate AERO® HDS-3 catalyst!

AERO HDS-3 is Cyanamid's brand-new nickel-molybdenum catalyst. Its biggest advantage is an unparalleled capacity for removing nitrogen and polyaromatics. In life tests, it markedly outperformed—and lasted longer than—conventional cobalt-molybdenum catalysts. It is also superior in sulphur-removal; in improving the color of waxes; in hydrogenation of feedstocks and middle distillates.

Behind this newest catalyst lies the experience of Cyanamid as a major producer of both catalysts and other chemicals. That experience is yours when you call your Cyanamid salesman—"The Man with the Golden Rule." Ask him—or write us—for the full data on AERO HDS-3.

Basic in catalyst chemistry

CYANAMID

AMERICAN CYANAMID COMPANY • REFINERY CHEMICALS DEPARTMENT • Bound Brook, New Jersey

REPORT TO REFINERS: HOW MUCH CAN CHEMICAL ADDITIVES DO FOR REFINED PRODUCTS?

ARMOUR IDEA CHEMICALS *an informative look at the use of Armour Idea Chemicals in gasoline, fuel oil, lubricants, asphalts... plus a glimpse at the research that is helping to solve today's problems and investigating tomorrow's needs*

GASOLINE ADDITIVES

More and more petroleum refiners are becoming aware of the abilities of Armour Duomeen® and Armeen® compounds as gasoline additives.

Duomeens O and C adsorb onto the metal surfaces of carburetors, forming monomolecular films which function as effective anti-icers. As a result, moisture—which causes engines to stall at temperatures around 36° F.—does not adhere to the surface. Even though ice particles may form under extreme conditions, they will not collect on the carburetor surface to block the flow of the air-gas mixture.

Recent investigations have revealed another important ability of Armeens and Duomeens: they help maintain engine cleanliness when used in summer gasolines.

Armour researchers are continually investigating the other Idea Chemicals for use as gasoline additives. Recent tests demonstrate that a new class of polyfunctional amines offer outstanding performance as corrosion inhibitors, de-icers and detergents.

FUEL OIL ADDITIVES

To supply bright, sludge-free fuel oil is the ultimate aim of every refiner. Many factors have made this a difficult goal to reach: stocks, fuel blends, transportation difficulties, processing. These conditions often result in fuel oil instability, which is further aggravated by the long storage periods necessary between peak seasonal demands.

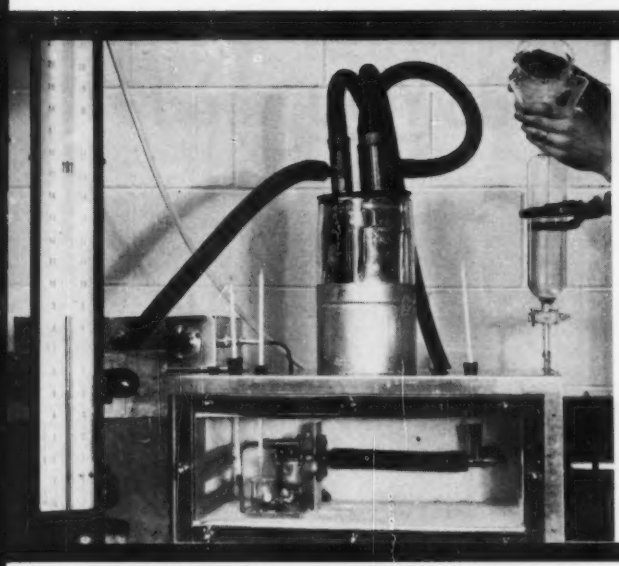
Two Armour chemicals relieve the problem. Armour Armolad® compounds help inhibit sludge formation; Armour Arquad® additives disperse it when it is already present.

The Armolads disrupt the normal chain reaction of oxidation and polymerization—thus minimize gum formation. In addition to stabilizing the oil in this manner, they also maintain color and filterability.

Armour Arquads 2C and 2S provide the ounce of prevention that's worth a pound of cure. These cationic surface active agents peptize the sludge while it is in the tank; the sludge thus passes through the burner system without plugging filters and nozzles. Arquads also act as detergents. Sludge already deposited on the screen can be resuspended and dispersed as described above. Another common source of possible contamination—mixing of fuels by the consumer -can be remedied also by the presence of a good dispersant additive.

LUBRICANT ADDITIVES

With advances in technology, lube oil requirements have become increasingly demanding. A progressive research program has been established at Armour to improve lubricant performance characteristics, such as wettability and lubricity.



ARMOUR RESEARCHERS AT WORK

TESTING CARBURETOR DE-ICING... At left in a test determining the ability of Armour additives to prevent carburetor icing. The carburetor is enclosed and air and humidity are uniformly maintained. A vacuum pump operates the carburetor, and icing is determined by the increase in vacuum. Armour chemicals are then tested for speed and efficiency of de-icing.

TESTING OIL STABILITY... Here, at right, an Armour technician measures the oxidation stability of turbine and hydraulic oils. The oils are placed in a controlled-temperature bath. Oxygen is bubbled through at a determined rate and the solution is then tested for acid and gum formation, viscosity stability, and corrosion.

Careful scrutiny is being given to the area of synthetic lubricants. Recent tests reveal the efficiency of tertiary amine chemicals in stabilizing synthetic diester lubricants. One of these tertiaries, Armeen M2HT, reduces the acid attack on bearings at concentrations as low as 0.1%.

ASPHALT ADDITIVES

In recent years greater use is being made of asphalt emulsions because they are less expensive and less hazardous than asphalt cements. Also, they can be stored and applied at much lower temperatures.

Armour cationic chemicals serve as efficient emulsifiers for new cationic asphalt emulsions. Duomeen T, because of its superior adhesion characteristics, develops a firm bond between the asphalt and aggregate; displaces water; prevents stripping. Atmospheric conditions have little effect on the adherent properties of the emulsified asphalt: deposition is rapid on either wet or dry surfaces.

In addition to cationic asphalt emulsifiers, Armour also produces Redicote® anti-stripping agents for asphalt cutbacks. The addition of as little as 0.2% Redicote to the asphalt will improve adhesion of asphalt to a wet or dry aggregate surface.

CHEMICALS THAT HELP INHIBIT ACID AND CORROSION

Refiners have found Armour chemicals useful in the field of metal cleaning. Small amounts of Armohib® additives retard acid attack on metals without diminishing the cleaning action of the acids. Armohibs are easy to use; liquid; readily soluble in acids; nonstaining; do not precipitate while standing. They offer users low-cost, dependable acid inhibition over a wide range of temperatures.

In addition, Duomeens and Duomeen salts are effective as refinery corrosion inhibitors. In treating pipe still overheads and light hydrocarbon streams, these chemicals perform efficiently at temperatures of 250-500° F., and concentrations of 6-12 ppm.

REORGANIZATION

The Armour Industrial Chemical Company has reorganized its derivatives department in order to offer you quicker, more expert technical assistance. Your Armour representative is now a member of our newly formed petroleum section—a department composed entirely of petroleum experts...men who know the oil business and understand its problems.

The new home base of this department is in Dallas, Texas, focal point of activity in the oil industry.

Call your petroleum chemical expert today. Let him show you how you can put Armour Idea Chemicals to work—productively...economically. For complete details on Armour Idea Chemicals for oil refining, send the coupon.

Petroleum Chemical Sales Department

Armour Industrial Chemical Company

One of the Armour Chemical Industries

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ARMOUR INDUSTRIAL CHEMICAL COMPANY
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Please send me your booklet on
Armour Idea Chemicals for Oil Refining.

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For more data on advertised products, use cards, last page.

"What kind of Pumping Control do YOU need?"

Square D can deliver it from Stock!

BASIC PANEL can be tailored to fit your needs—

- NEMA Type 3 "weatherproof" enclosure protects against rain, sleet, hail, snow and dust.
- simplified installation—convenient knockouts for easy wiring, designed for either wall or pole mounting, or available with pedestal mounting feet if desired
- oversized enclosure permits field installation of additional features if required
- choice of fusible disconnect switch or circuit breaker
- HAND-OFF-AUTO selector switch
- available in ratings up to NEMA Size 4 to handle up to 100 hp

COMPLETE PROGRAMMING PANEL has every feature you need for oil well pumping—

- two types—one for operation up to 600 volts, another for 762-volt systems
- gasketed inner door isolates "live" parts—NEMA Type 3 enclosure gives complete weather protection
- overload relays in separate ventilated compartment to prevent nuisance tripping
- time clock has trip tabs for easy pumping program setup
- undervoltage release relay drops out on power failure, provides time-delay restart for staggered starting when power is restored
- built-in lightning arrester

Write for Bulletin 8944. Square D Company, 4041 North Richards Street, Milwaukee 12, Wis.

SQUARE D COMPANY

—wherever electricity is distributed and controlled

PERFORMANCE AND ACCEPTANCE

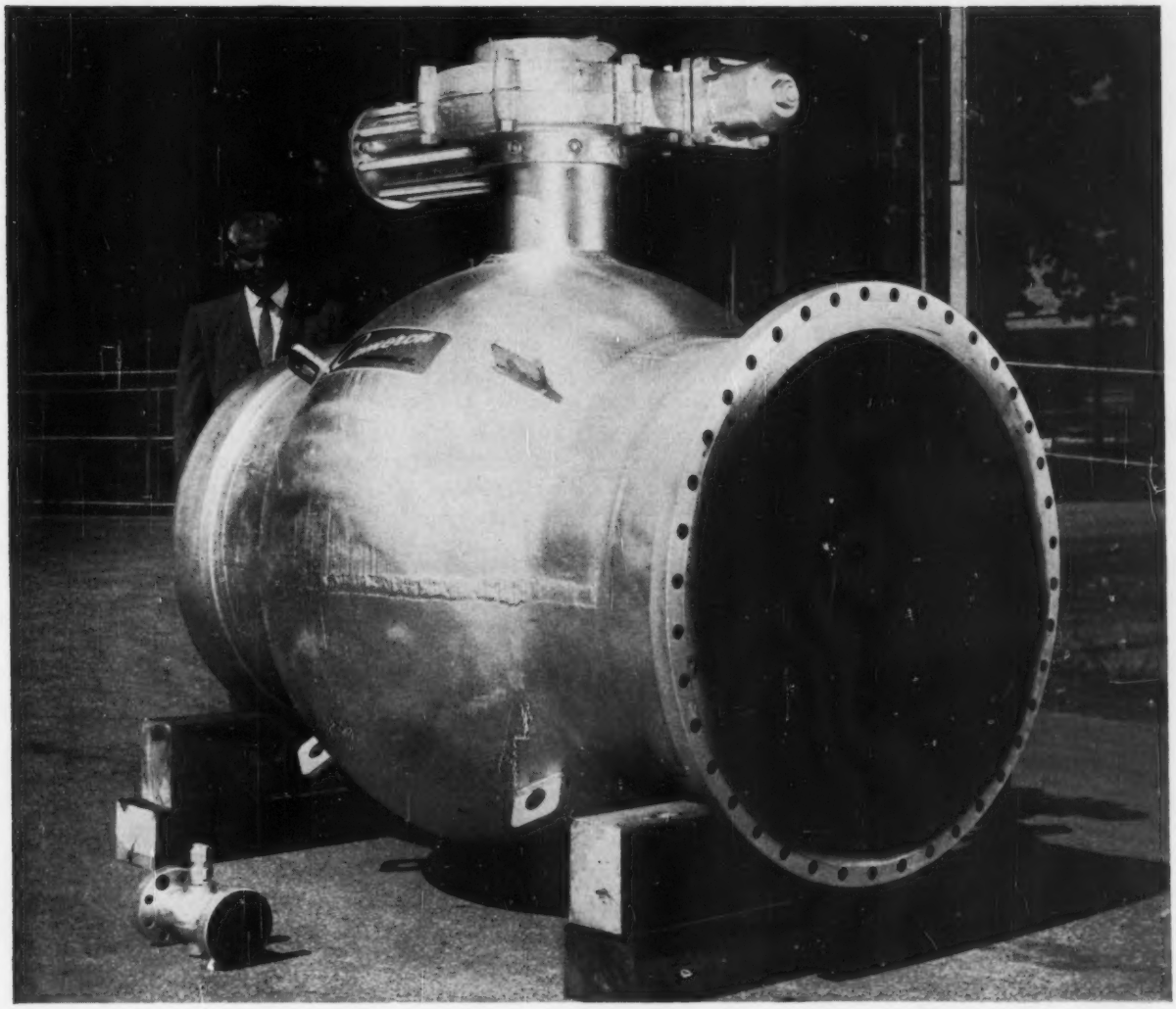
Repeat orders roll in for Cameron Ball Valves. Enthusiastic reports from test installations during the past three years show performance justifying every claim.

The reasons for this enthusiastic acceptance are plain – simplicity, with a minimum of parts – no bonnets or glands to leak – no lubrication for bearings or seal – easy to operate with Teflon bearings – tight shut-off indefinitely, with rotating seats – sealed for life, no maintenance.

Plan now to profit from the trouble-free operation and lack of maintenance expense of Cameron Ball Valves.

Cameron

CAMERON IRON WORKS, INC.
P. O. BOX 1212 HOUSTON, TEXAS



CAMERON BALL VALVES

Available in sizes 2″ through 42″

For more data on advertised products, use cards, last page.

It's new and exclusive...

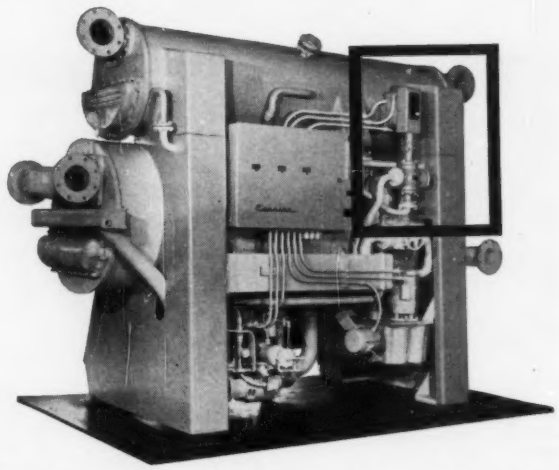
CARRIER SOLUTION CAPACITY CONTROL

with Automatic Absorption Refrigeration cuts operating costs to an all-time low!

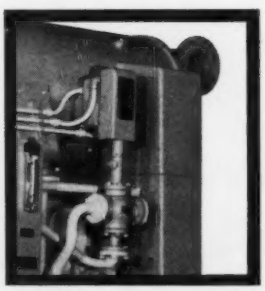
Through lower steam consumption per ton of refrigeration when working at partial load, Carrier Solution Capacity Control cuts operating costs. Since refrigeration equipment seldom works continuously at full load, the savings it effects can be substantial. With it, full advantage may be taken of the lowest possible steam rates. Results: Maximum economy and peak efficiency.

Two other advantages of Solution Capacity Control: (1) Steam pressure always remains constant. There's no need for manual or costly automatic steam control valves. (2) In addition to reducing steam consumption at partial loads, this Carrier development lowers the temperature of the condenser water leaving the machine and also eliminates bleeding of air into the condensate system. Results: Longer life, reduced water treatment requirements and few shutdowns.

Available for either electronic or pneumatic operation, Solution Capacity Control is now standard on all Carrier Automatic Absorption Liquid Chilling Packages. It can be installed with only minor adaptation at job-site on existing Carrier units. A Carrier representative will be glad to give you complete information about it. Write Carrier Air Conditioning Company, Syracuse 1, New York. In Canada: Carrier Air Conditioning Ltd., Toronto 14.

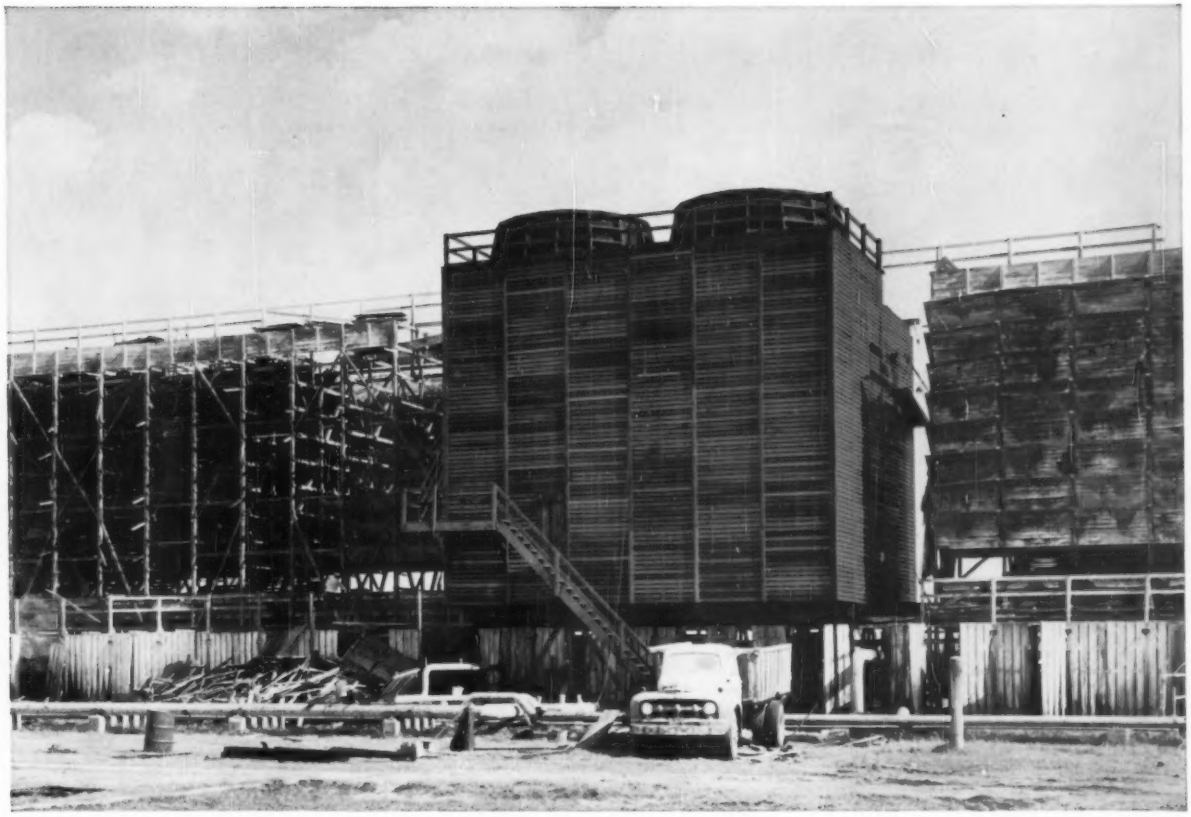


For air conditioning or process cooling, the Carrier Automatic Absorption Liquid Chiller uses low-pressure steam, high-temperature hot water or other hot liquids to produce refrigeration. Capacities: 50 to 1000 tons.



Solution Capacity Control System precisely controls machine output by reconcentrating only enough lithium bromide solution to handle the refrigeration load. When operating at partial capacity, the excess portion of full load solution is bypassed through the capacity control valve – positioned automatically in response to chilled water demands. Capacity control avoids all the additional heat loss which would accompany the unnecessary heating and cooling of the solution.

Carrier Air Conditioning Company



HUDSON EXPERIENCE IN COOLING TOWER REPAIR, REMODELING AND REPLACEMENT — ASSURES SPEED, SKILL, AND INTEGRITY

For instance the above pictured HUDSON induced draft tower, 36 feet long, was erected in the area and on the foundations formerly occupied by the mid sections of a 162 feet long deteriorated natural draft tower. Exposed-tube coolers in the base of the original tower were left in place, and cooled water from the new tower distributed over these coolers. The completed installation is shown below.

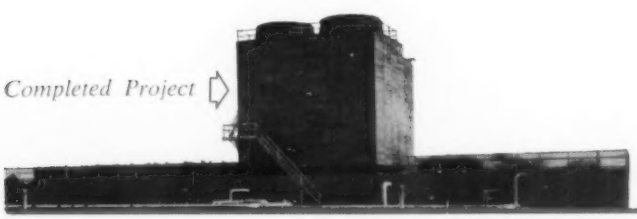
The work of dismantling, remodeling, and erection required 27 working days, and total shutdown time was less than 24 hours.

Although deterioration of the old tower necessitated its replacement, plant records show that increased revenue due to lower operating costs and greater product yield because of colder water, will give a *quick return of the investment.*

HUDSON maintains a cooling tower repair and replacement department staffed with experienced engineering and field personnel. Materials are stocked at HUDSON fabricating centers in California and Texas. If your cooling tower is *obsolete* or deteriorated avail yourself of HUDSON cooperation in developing the most economic replacement program.

In addition to water cooling towers HUDSON designs and manufactures SOLO-AIRE units (for cooling solely with air), and COMBIN-AIRE units (for cooling with combination of air and water). Only HUDSON is equipped to integrate these all-encompassing categories of equipment into cooling systems balanced to meet most economically specific conditions of climate, quantity and quality of water, and processing requirements.

Completed Project ⇨



HUDSON

ENGINEERING CORPORATION

BRAEBURN STATION • HOUSTON, TEXAS

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Steam trap dependability is a matter of what the manufacturer puts into the trap

ARMSTRONG TRAPS ARE DESIGNED AND MADE TO GIVE YOU DEPENDABILITY

1. Efficient, proved operating principle

Armstrong Traps provide the most advanced development of the time-proven inverted bucket principle. Simple, but effective, there isn't much that can go wrong.

2. Good design

Armstrong Trap design gives big capacity in a small package. The mechanism is virtually fool-proof. All body styles are easy to inspect and maintain without removal from the line.

3. Highest quality materials of construction

Only the best goes into Armstrong Traps. Bodies are close grained 30,000 tensile iron castings or high quality forgings. Working parts are all tough, corrosion resistant stainless steel.

4. Good workmanship

Armstrong Traps are made by craftsmen who take pride in their work. Careful inspection and frequent checking insure the quality of the trap.

5. Application know-how

Your problem has probably been solved already in the extensive experience of the Armstrong engineering and sales organization. You can be sure of sound, dependable recommendations.

Your local Armstrong Representative can show you what Armstrong dependability can do for you. Call him today or write direct.

860 Series for low pressure heating service.

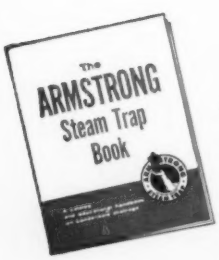
800 Series, side inlet, side outlet.

No. 801, side inlet, bottom outlet.

880 Series, integral strainer.

200 Series, bottom inlet, top outlet.

Forged Steel Series for high pressures, high temperatures.

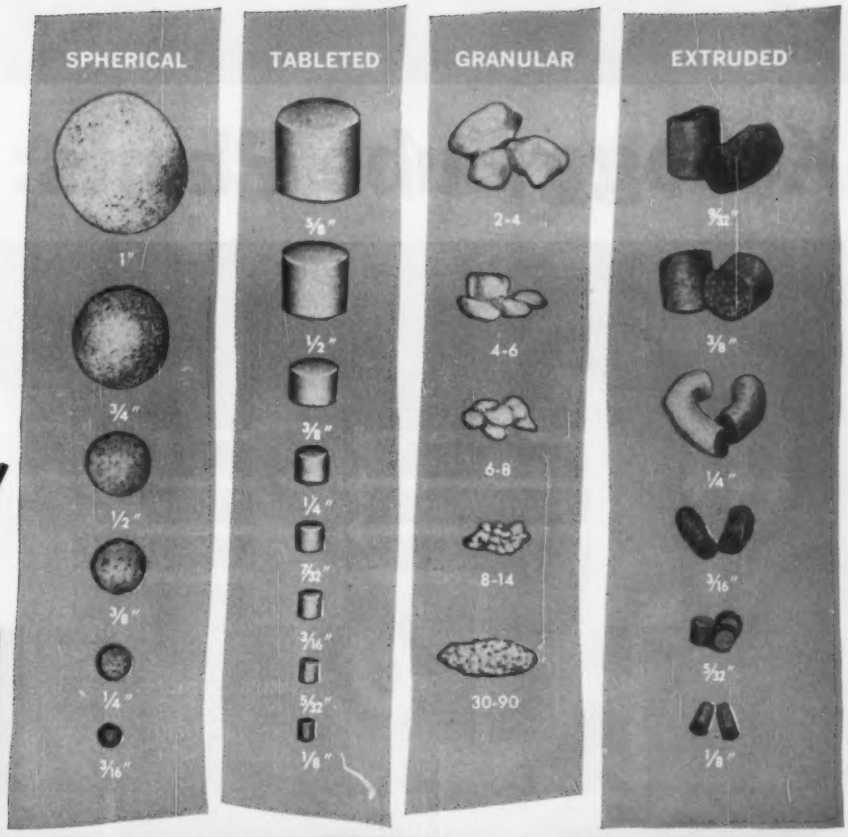


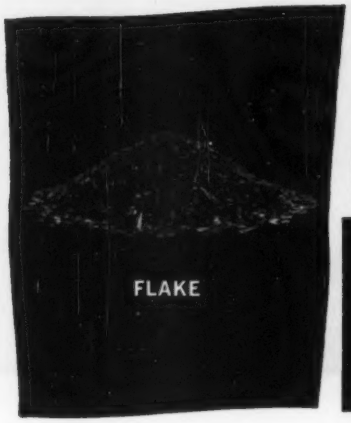
The 48 page Armstrong Steam Trap Book tells how to correctly size, install and maintain steam traps for any pressure, any temperature, any load plus full catalog data on Armstrong Steam Traps. Ask for Catalog K.

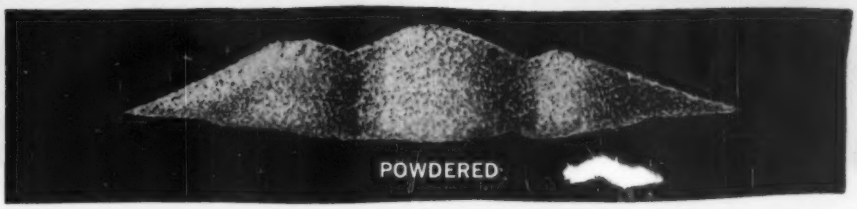
ARMSTRONG MACHINE WORKS

8521 Maple Street **Three Rivers, Michigan**

HARSHAW can make the catalyst you *Specify!*







HARSHAW

has the facilities for producing carload quantities of

PREFORMED CATALYSTS

to fit special process requirements

Hydroforming	Dehydration
Cyclization	Desulphurization
Oxidation	Alkylation
Dehydrogenation	Isomerization
Hydrogenation	

Write for FREE Booklet, "HARSHAW CATALYSTS"

CATALYTIC CHEMICALS SUPPLIED BY HARSHAW

Aluminum Nitrate		Cobalt Nitrate
Copper Nitrate		Manganese Nitrate Solution
Metallic Soaps (Cobalt, Manganese)		
Nickel Carbonate	Nickel Formate	Nickel Nitrate
Nickel Sulfate	Sodium Methoxide	Zinc Nitrate

Our experienced technical staff will assist you in developing the best and most economical catalyst. If you have a catalytic process in the development or production stage, a discussion with us may prove beneficial.

THE HARSHAW CHEMICAL CO.

1945 EAST 97th STREET • CLEVELAND 6, OHIO

Chicago • Cincinnati • Cleveland • Detroit • Hastings-On-Hudson
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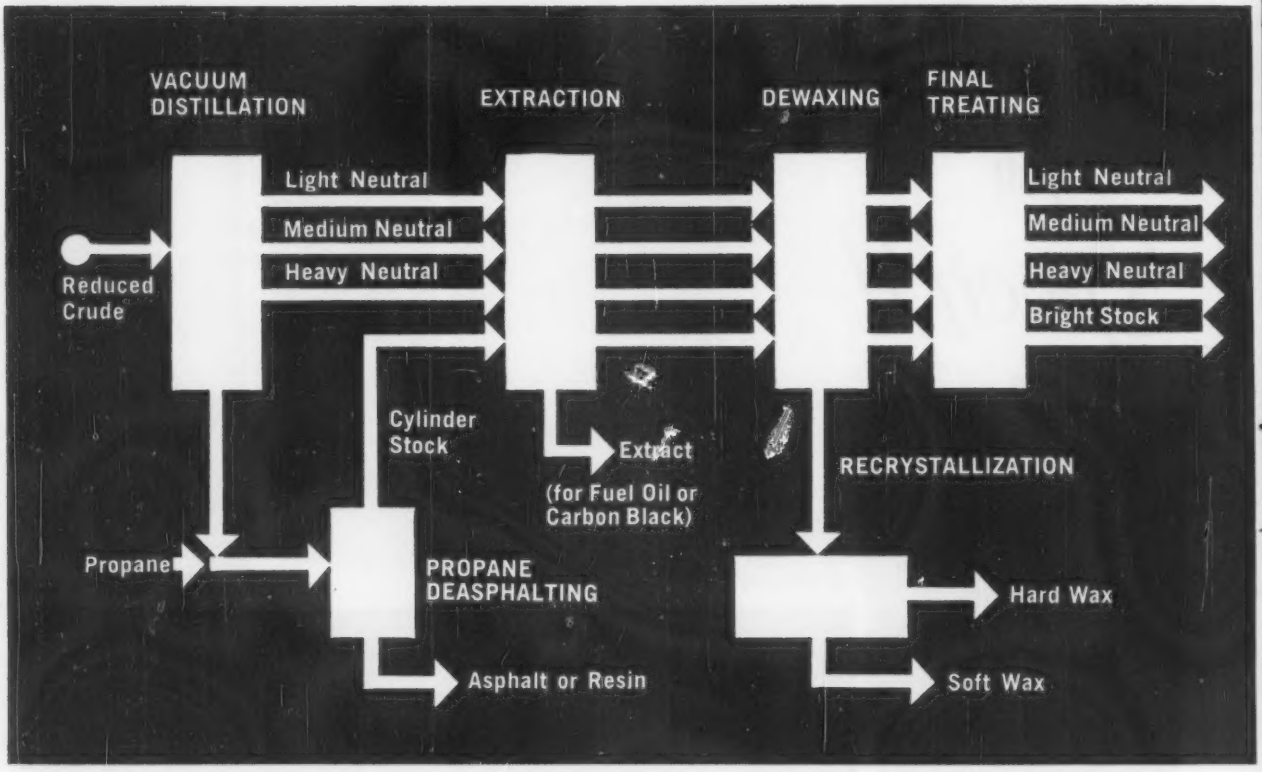
For more data on advertised products, use cards, last page.

Kellogg Lube Plants: Two Basic



PROPANE DEASPHALTING

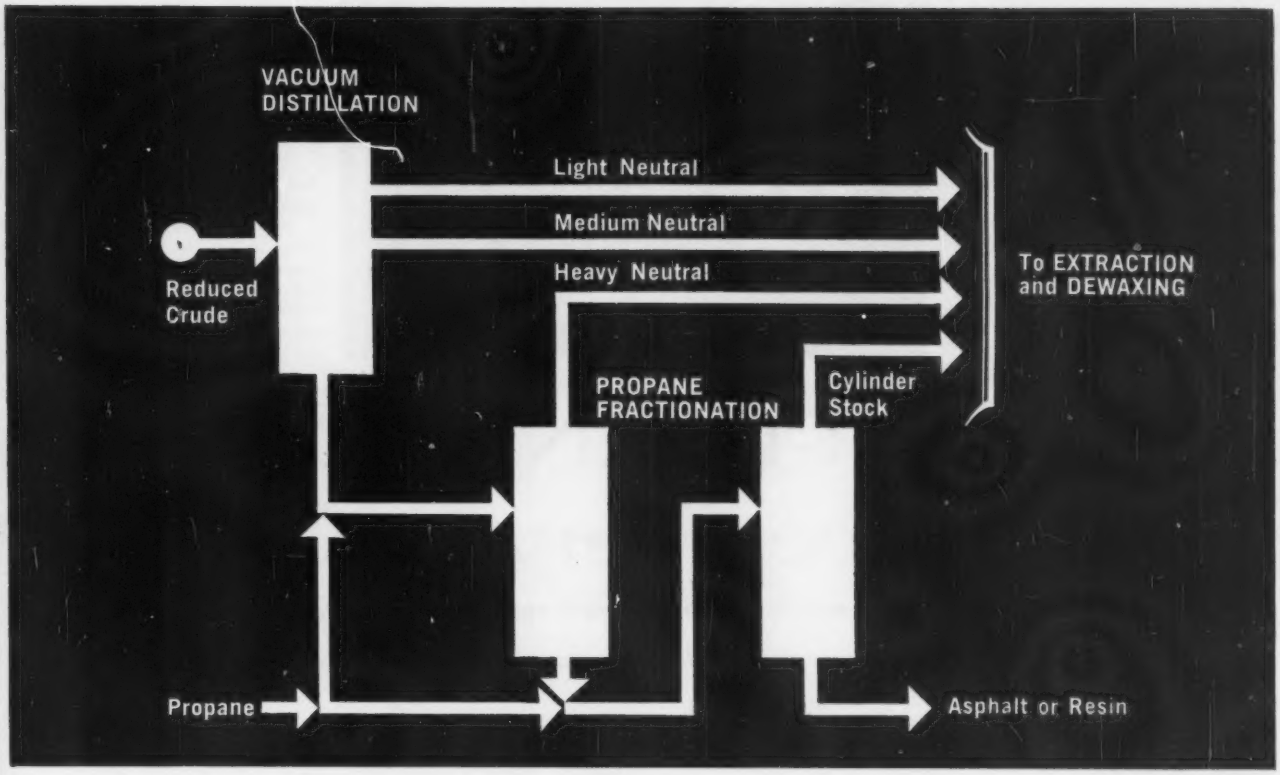
To refiners processing lube-bearing crudes, a Kellogg-designed lube plant can offer an attractive route to increased profits. To refiners currently processing lube fractions in older equipment, a Kellogg-designed revamp or expansion can mean lower operating cost per barrel.

Kellogg offers two basic routes to lube oil production, each of which can be tailored to meet individual marketing needs.

The first is based upon propane deasphalting, a continuous process designed to separate cylinder stock from vacuum tower bottoms. Cylinder stock and raw neutrals from the vacuum unit are then processed to produce blending stocks having improved viscosity index, color, and oxidation stability. In cases where waxy stocks are processed, dewaxing is employed to separate high-pour waxy materials from lube fractions. If desired, a recrystallization step can be added to recover valuable hard waxes.

The second route is based upon propane fractionation. Both heavy neutral and cylinder stock are separated from vacuum residue through use of a two-stage deasphalting sys-

Routes to Increased Profits...



PROPANE FRACTIONATION

tem. This route is recommended for client situations requiring a high yield of high quality heavy neutral.

The two basic flowsheets shown are backed by Kellogg's 30 years of experience in lube processing and embody a number of major improvements in engineering design—fruits of a continuing development program. These improvements—such as use of multiple-effect solvent evaporators and centrifugal contactors in phenol extraction units—make investment in a modern lube plant more attractive than ever before.

Since 1930, Kellogg has engineered and/or built 100 basic lube oil units. For further information on how this experience can be brought to bear on *your* lube plant needs, you are cordially invited to discuss your needs with Kellogg's lube oil specialists.

THE M. W. KELLOGG COMPANY

711 Third Ave., New York 17. *A subsidiary of Pullman Incorporated*

The Canadian Kellogg Company, Ltd., Toronto
Kellogg International Corporation, London
Societe Kellogg, Paris
Kellogg Pan American Corp., Buenos Aires
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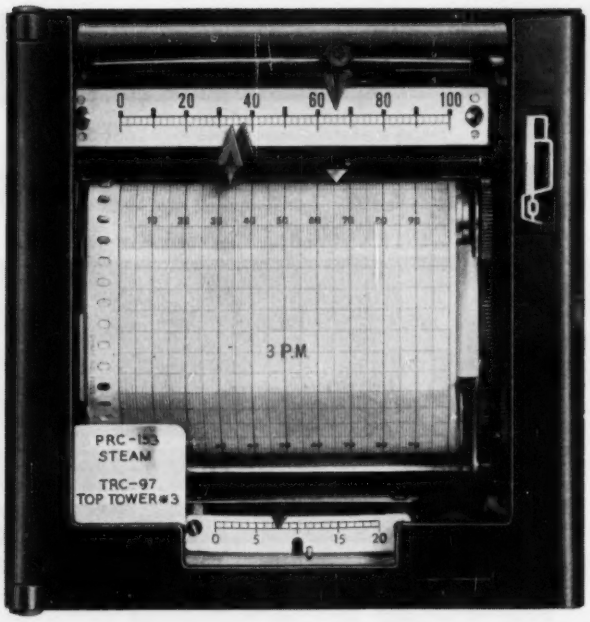


New Bristol Series 670 Metagraphic receivers measure only 7″ wide by 7⅛″ high on panel, come in a wide selection of models, including 1-, 2-, and 3-pen models and models with manual-automatic, manual-cascade, and manual-automatic-cascade control stations.

Now: the USER-PLANNED Receiver *New Bristol Metagraphic*

offers you more features for easy installation, flawless operation, and fast, no-down-time servicing than any other 4-inch-chart pneumatic receiver.

At last, here's the ideal pneumatic receiver for graphic panel applications.

It's Bristol's new Series 670 Metagraphic, the receiver with complete plug-in versatility and convenience, plus these new user-designed features:

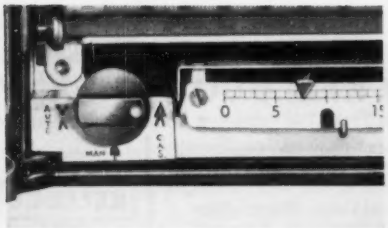
Simplified control switching between functions—Allows the easiest start-up procedures for automatic or cascade operation. Just adjust process to line up color-coded indicators and switch to automatic or cascade operation as desired.

Uniform control switching—All receiver models have the same convenient, easy-to-remember switch positions for the various types of control: cascade position; 3 o'clock; manual position, 6 o'clock; and automatic position, 9 o'clock.

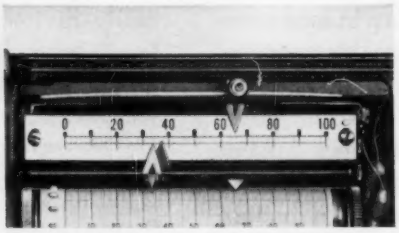
Simplified chart change and inking—Chart changing is a one-hand operation. A new chart can be slipped into place in an instant. The capillary inking system can be filled from the front of the receiver.

And that's not all: Series 670 gives you such outstanding features as rectilinear chart coordinates for easiest reading, easy connections for any type of control, and sparkless mercury-switch disconnect of electrical circuit when plug-in chassis is withdrawn.

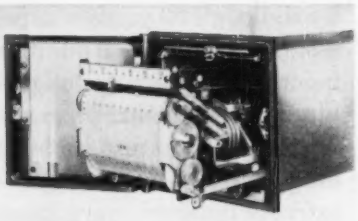
Write for complete data on the new Series 670 today. The Bristol Company, 111 Bristol Road, Waterbury 20, Conn., a Subsidiary of American Chain & Cable Company, Inc. 0.43



Simplified, uniformly-planned control switching facilitates process start-up and operator training.



Brightly-colored distinctively-shaped pointers signal process deviation from set-point, even at a distance.



Complete plug-in versatility—long a Metagraphic feature—insures continuity of service.

BRISTOL...for improved production through measurement and control

AUTOMATIC CONTROLLING, RECORDING AND TELEMETERING INSTRUMENTS

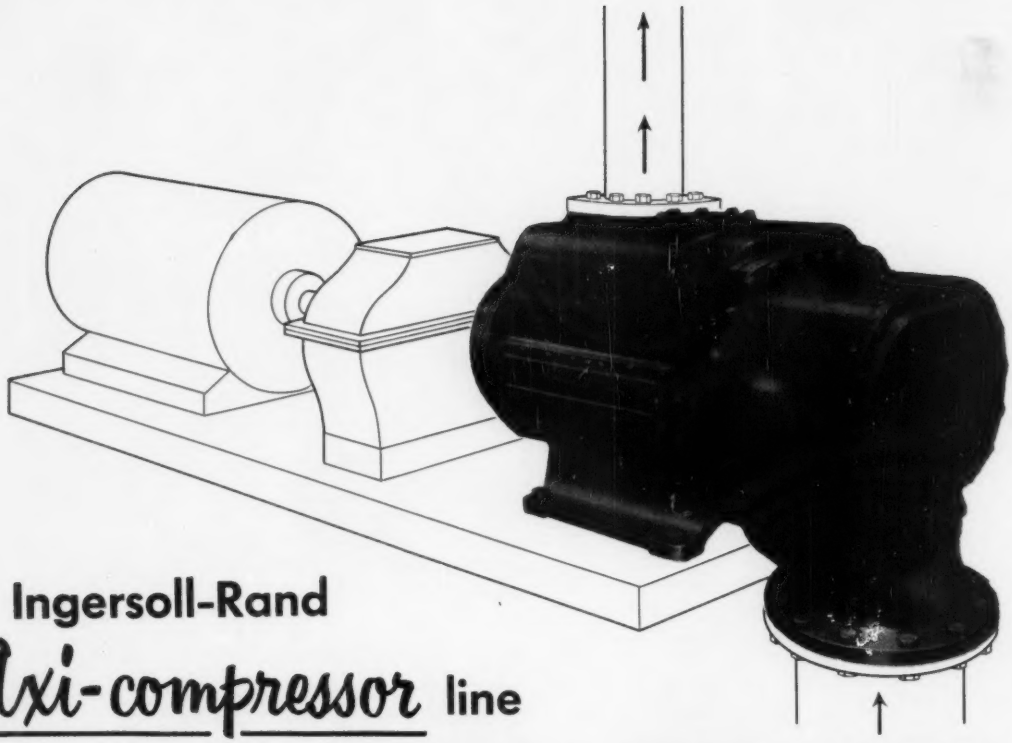
A CLEAN FRESH DRINK
...from salty water

From the highly mineralized salt water found in the deep wells of New Mexico, the fast growing city of Roswell will soon draw fresh drinking water into its municipal system. The Office of Saline Water (U.S. Department of the Interior) selected CATALYTIC from a group of sixty-five firms for the architect-engineering assignment of the conversion demonstration plant which will make this possible.

This is another example of CATALYTIC'S versatility as engineers and constructors in all fields of today's complex industrial expansion and the national defense program.

CATALYTIC
CONSTRUCTION COMPANY
PHILADELPHIA 2, PENNSYLVANIA

In Canada: Catalytic Construction of Canada, Limited; Sarnia, Ontario

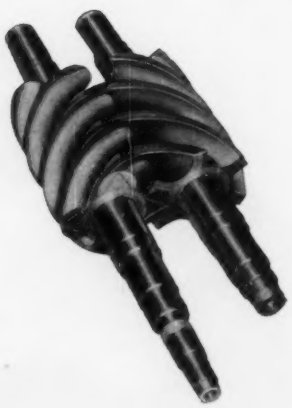


Ingersoll-Rand *Axi-compressor* line extended to HIGHER PRESSURES

- **New Type H Heavy-duty Axi-compressor designs provide compression ratios up to 4.5 per stage**
- **With atmospheric inlet, deliver up to 50 psig discharge pressure**

SUPPLEMENTING the service-proved line of Ingersoll-Rand Axi-compressors, the new Type H units extend the advantages of positive-displacement axial-flow rotary compression to higher pressures than were previously obtainable. Two meshing rotors draw the air or gas in at the outboard end, compress it axially by pulsation-free positive displacement and deliver the pressurized gas through the top discharge at the driver end of the casing.

Features include dynamically-balanced rotors, water-cooled casings and force-feed lubrication to all bearings and timing gears and cooling oil to internally-cooled rotors when required. For many conditions of capacity and pressure, this rotary oil-free positive displacement compressor serves better than either reciprocating or centrifugal compressors. Ask your Ingersoll-Rand engineer for complete information, or send for Bulletin 11,015 today.



ONLY TWO MOVING PARTS
Compression takes place between these two meshing rotors. All motion is rotary and no valves are required.

OIL-FREE COMPRESSION
Since the rotors do not touch each other or the casing, no lubrication is required in the compression chamber.

MINIMUM SPACE REQUIREMENTS
Unusually compact design saves both floor space and head room. Smooth running balance permits small, inexpensive foundations.

Ingersoll-Rand
195A 17 11 Broadway, New York 4, N.Y.

THE WORLD'S MOST COMPREHENSIVE COMPRESSOR EXPERIENCE

"Made OF Stainless Steel ...Made BY Jenkins"

And the "BY" is the most important word in that Spec!

Let's talk sense about stainless steel valves.

The material, the metal itself, is pretty much a cut-and-dried matter of *specifications* — selecting the right metal for a particular application. After all, the same alloys are available to *all* valve manufacturers!

But —

Just as is the case with iron or bronze valves, the basic and essential difference is in the *way* valves are made. *Perfection of castings . . . precision machining . . . sound design . . . painstaking inspection and testing —*

These are the really meaningful, the sense-making factors which impel more and more buyers to specify "BY Jenkins," along with the specification for a particular alloy.

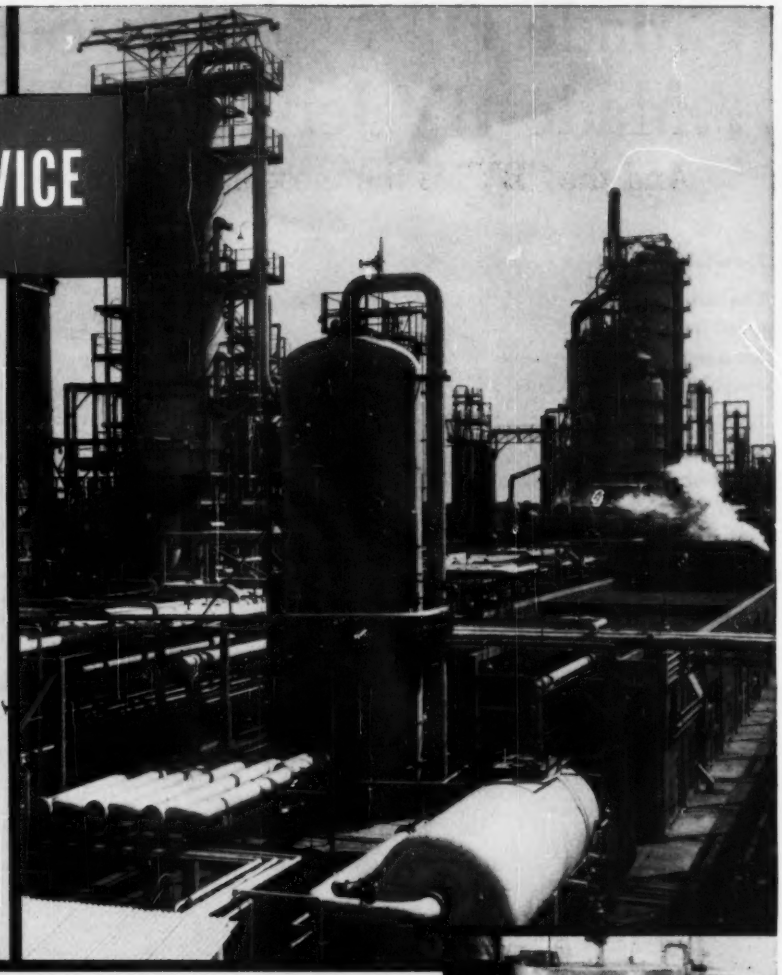
At Jenkins every operation, every process, every test, every worker — all combine to fulfill the traditional (almost 100 years old!) standard of Jenkins quality — the very highest, the *standard* of quality for valves.

SEND FOR CATALOG 59-SS of Jenkins Stainless Steel Valves in types and alloys to fill 99 out of 100 application requirements. All made the Jenkins way to give you the longest, most dependable valve performance money can buy. Jenkins Bros., 100 Park Ave., New York 17.

For more data on advertised products, use cards, last page.

another
TRETOLITE SERVICE
report

KONTOL
Corrosion Inhibitor permits low pH operation in refinery's crude unit overhead system



OHIO OIL COMPANY GETS EFFECTIVE CORROSION CONTROL, BETTER PRODUCT QUALITY AT REDUCED COST

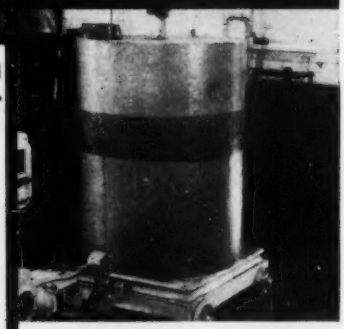
An outstanding performance record compiled over a five-year period in Ohio's refinery at Robinson, Illinois, proves the feasibility of low pH operation augmented by KONTOL* Corrosion Inhibitors.

Prior to inauguration of the low pH-KONTOL program, a high (7.5) pH operation on overhead receiver waters was fouling equipment. Heavy sludge deposits were accumulating ahead of exchanger baffles, and ammonia was contaminating hydrocarbon streams. These troubles limited the refinery to short runs at decreased capacity. *In addition, serious corrosion problems resulted in extensive equipment replacement and repairs after only nine months of operation.*

By changing to a low (4.0-4.5) pH and injecting KONTOL Corrosion Inhibitor at a rate of 10-15 ppm, Ohio has stopped sludging and greatly lowered ammonia contamination. Equipment has been kept clean, reducing maintenance costs and permitting longer runs at increased charge rates. Turnaround inspection has been lengthened to 18-month intervals. *No equipment failures due to corrosion occurred during this five-year period.*

Low pH operation supported by KONTOL corrosion control might offer important advantages for your refining facilities. Ask the Man in the Red Car to explain this program, or write . . .

*Registered trademark, Petrolite Corporation



Facilities such as this one for Kontol injection at various points are part of over-all corrosion control program at Ohio Oil Company's Robinson, Ill., refinery.

PETROLITE
CORPORATION

SUBSIDIARY AND AFFILIATED COMPANIES
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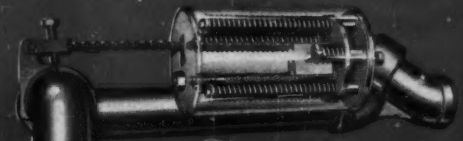
NETHERLANDS, The Hague • PERU, Talara • TRINIDAD, Port of Spain

KR-60-1

NEW CHIKSAN SPRING BALANCED LOADING ARM—

Here is a series of loading arms that is built to deliver solid performance right around the calendar. Outstanding new compression spring design offers finger-weight flexibility, yet the arm will not creep or sag when released. Springs are housed in a sturdy weatherproof steel case. Balance adjustments are accomplished with a hand wrench. The swivel joints on the arm have the dependability that has been associated with the name Chiksan for 30 years. Get the facts. Write for Bulletin 1-61.



FEATURING NEW TOTALLY ENCLOSED COMPRESSION SPRING—

Self compensating spring tension provides complete balance at any position. Compact design. No protruding brackets or counterweights.

4 MODELS FOR PETROLEUM SERVICE

Select from a complete line. All models—Folded Arm, Sliding Sleeve (shown above), Bottom Loader and Long Reach are available in 2, 3, and 4-inch sizes. Each model is a complete, ready for service, unit.

2 MODELS FOR CHEMICAL SERVICE

For loading or unloading virtually any chemicals, Chiksan offers a standard group of arms equipped with its DS series swivel joints. Available in Folded Arm model or Sliding Sleeve unit (shown at left).

WANT TO CONVERT EXISTING EQUIPMENT?

Chiksan Base Arm Sections permit operators to change existing facilities with minimum effort. Base Arm Sections are available in standard sizes of 2", 3", and 4". Riser joint supplied with threaded or flanged connections.

MAIL COUPON TODAY FOR COMPLETE INFORMATION

CHIKSAN fmc

#61-60

CHIKSAN COMPANY
330 North Brea Blvd., Brea, Calif.

Please send me your Bulletin 1-61.

Name_____

Title_____

Company_____

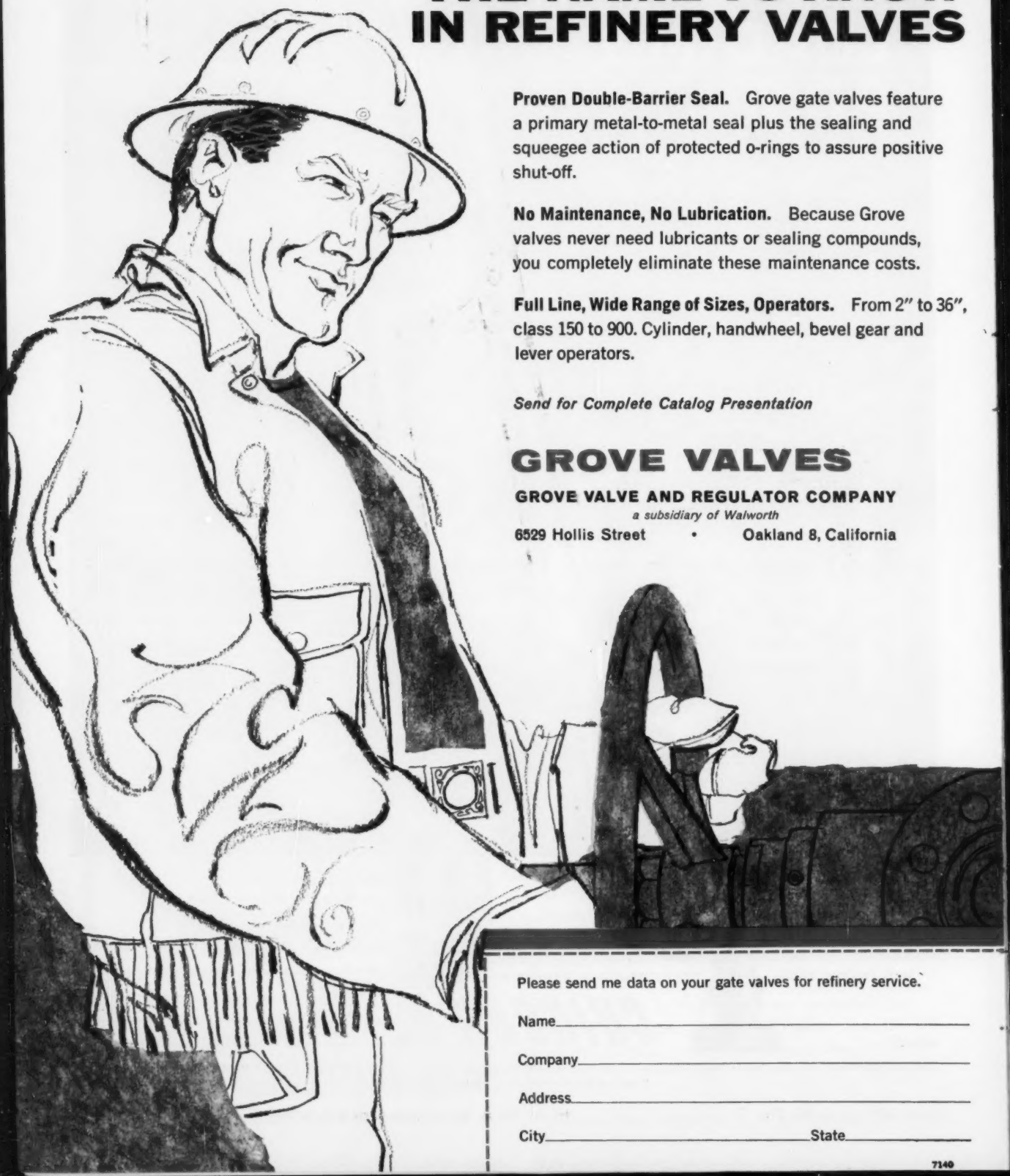
Address_____

City_____ Zone_____ State_____

CHIKSAN COMPANY—General Offices: Brea, California • Well Equipment Mfg. Corp. Division (Weco Unions, Hamer Valves) • Chiksan International • Chiksan of Canada Ltd.
Offices and Representatives in Principal Cities of the World

GROVE

THE NAME TO KNOW IN REFINERY VALVES



Proven Double-Barrier Seal. Grove gate valves feature a primary metal-to-metal seal plus the sealing and squeegee action of protected o-rings to assure positive shut-off.

No Maintenance, No Lubrication. Because Grove valves never need lubricants or sealing compounds, you completely eliminate these maintenance costs.

Full Line, Wide Range of Sizes, Operators. From 2″ to 36″, class 150 to 900. Cylinder, handwheel, bevel gear and lever operators.

Send for Complete Catalog Presentation

GROVE VALVES

GROVE VALVE AND REGULATOR COMPANY
a subsidiary of Walworth
6529 Hollis Street • Oakland 8, California

Please send me data on your gate valves for refinery service.

Name_____

Company_____

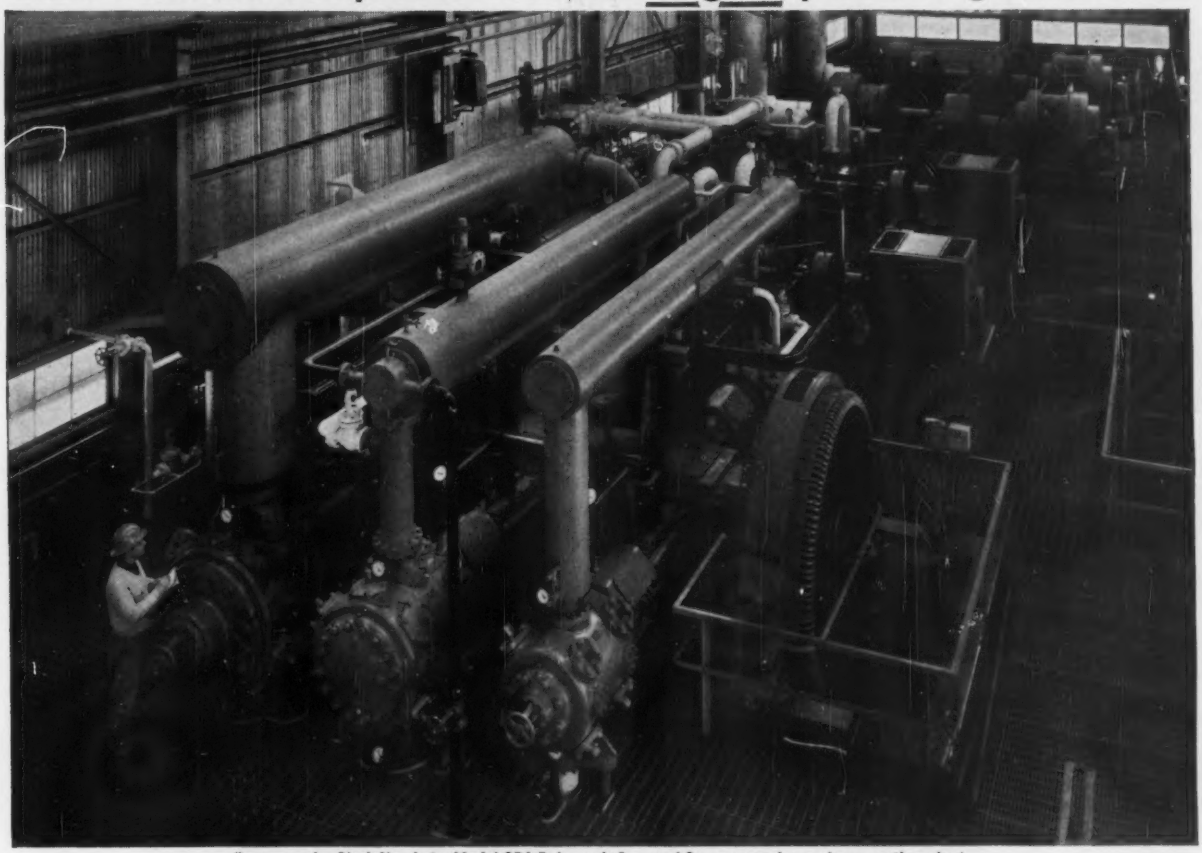
Address_____

City_____ State_____

7140

OVER 3000 HOURS ON STREAM...

Clark non-lube compressor still has original piston rings and trim!



Foreground—Clark Non-Lube Model CRA Balanced/Opposed Compressor in an air separation plant.

Uncontaminated nitrogen gas for a liquid oxygen refrigeration cycle is kept "bone dry" in this Clark Non-Lube Model CRA-6 Balanced/Opposed Compressor. Installed in Wheeling Steel's new air separation plant at Steubenville, Ohio, the 1250 bhp unit has shown remarkable dependability since startup. After going through initial blowdown, initial start-up, and 3000 hours on stream, the machine is still operating with its first set of piston rings and trim.

There are several reasons for this on-the-job endurance:

- The compressor operates at a conservative speed to hold down friction and temperature levels.
- Staging is extremely conservative—five stages are used to compress nitrogen from atmosphere to 565 psi.
- Non-lubricated, non-metallic piston rings, packing rings and riders are used to prevent hydrocarbon contamination of the gas stream.
- Compressor piston rods and cylinder liners are micro-polished to minimize wear and heat of friction.
- The non-lube cylinders are connected to the crankcase by extra long distance pieces. Lubricated areas of the piston rod do not enter the non-lubricated cylinder.
- Clark Balanced/Opposed design provides smooth, vibration-free performance. The foundation need only be large enough to support the weight of the compressor.
- Unit was furnished as a complete package with overhung motor, all intercoolers and interconnecting piping mounted on the compressor frame.

The new tonnage oxygen plant at Wheeling Steel is just one of many modern processes where Clark Balanced/Opposed Compressors have been specified because they can do the job best.

Air or gas, lube or non-lube, 75 to 8000 bhp, vacuum to 50,000 psi . . . Clark has the compressor—and the experience—to help you make the most profitable choice. The next time you plan a new facility, take advantage of them both. Contact your nearest Clark representative *first!*

CLARK BROS. CO. OLEAN, N. Y.

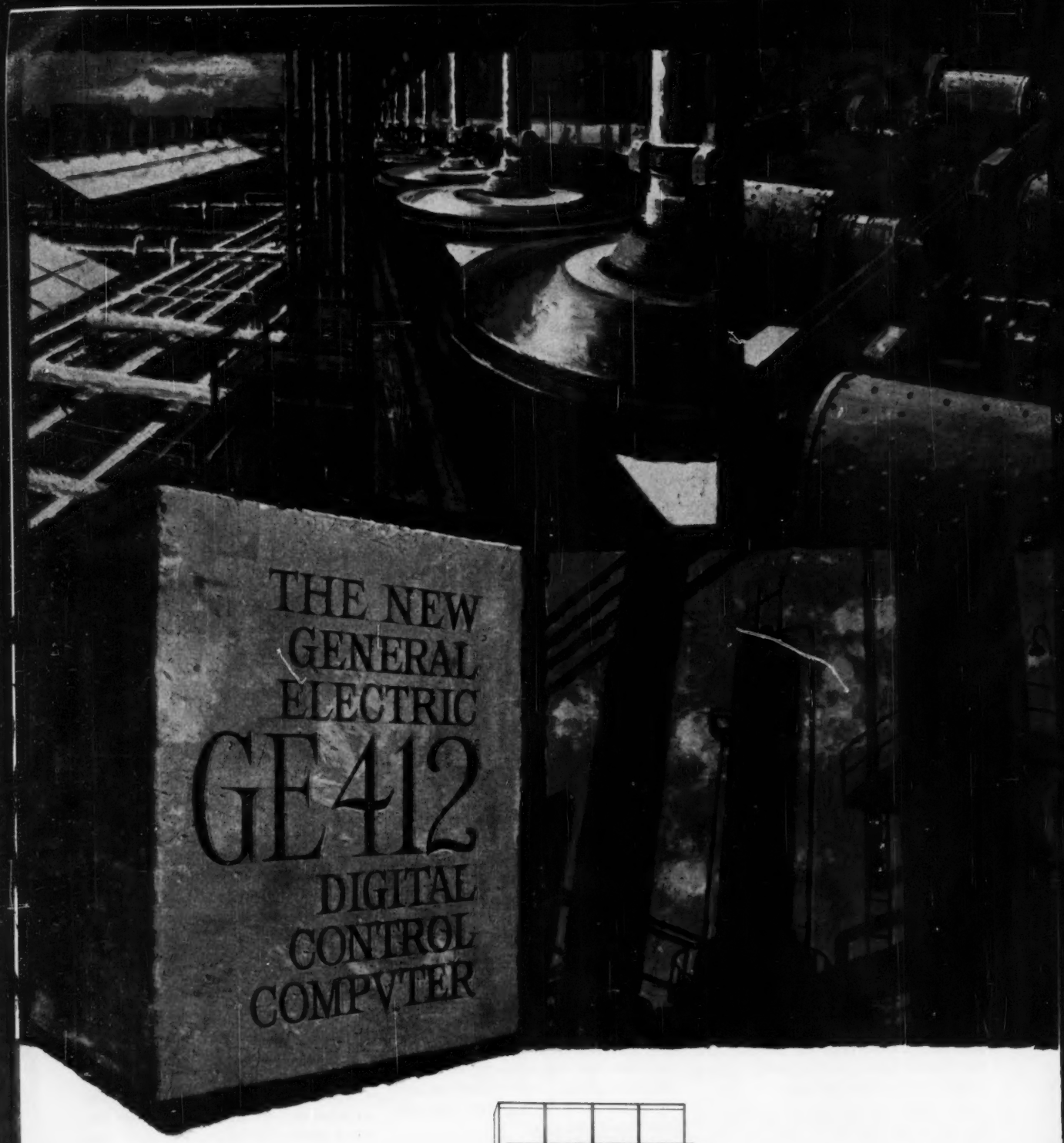
ROOTS CONNERSVILLE — Blowers, Compressors, Gas Pumps, Rootsmeters, Vacuum Blowers

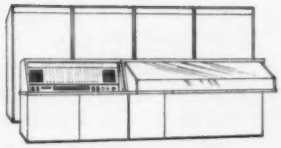
Working together in allied industries . . .

PODBIELNIAK — Centrifugal Contactors, Distillation Apparatus, Instrumentation

CLARK — DRESSER INDUSTRIES INC. — OIL • GAS • CHEMICAL ELECTRONIC • INDUSTRIAL

For more data on advertised products, use cards, last page.





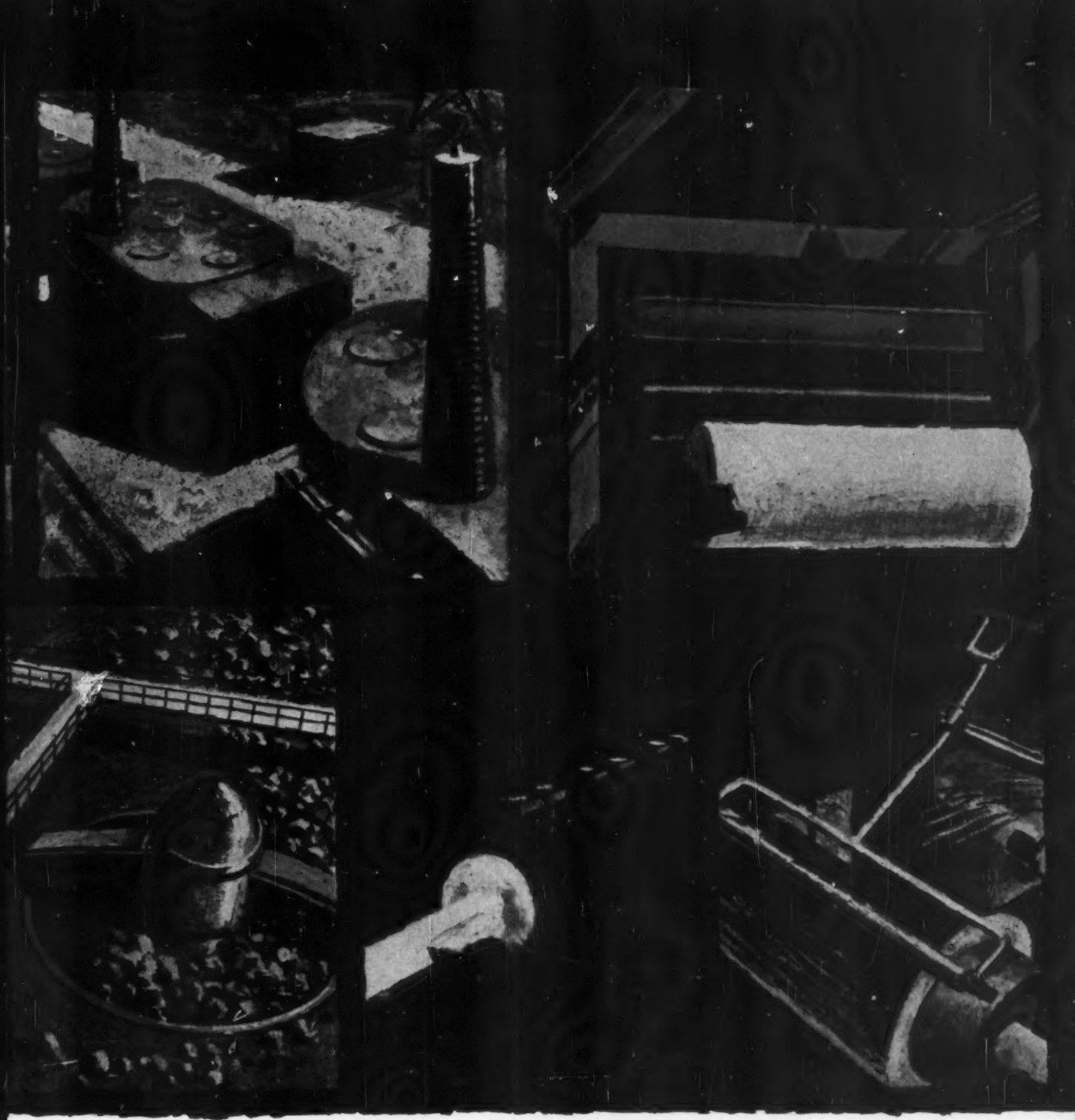
CORNERSTONE FOR YOUR AUTOMATION PROGRAM

CHEMICALS • ORE REDUCTION
PETROLEUM REFINING • PAPER • GLASS
CEMENT • ALUMINUM • UTILITIES • STEEL

PCA-2

General Electric announces the new GE 412, a second generation solid-state, stored program computer designed solely for industrial and utility applications.

The GE 412 Digital Control Computer, new "big brother" in the General Electric family of process computers, has been designed with the total systems concept and flexibility of equipment organization in mind.



The resultant versatility and capability of the GE 412 makes it custom-adaptable to many particular applications in many varied industries—data-logging and monitoring, data-logging and control, economic dispatching, director (or dispatcher) in a multi-control system.

The new GE 412 is extremely fast—capable of 25,000 additions a second. It incorporates a core memory with drum memory backup, plus more than 100 basic commands, to provide wide programming flexibility. The Automatic Program Interrupt feature and Programmable Elapsed Time Counters permit the regular survey of critical points without wasting valuable computer time required for constant checking.

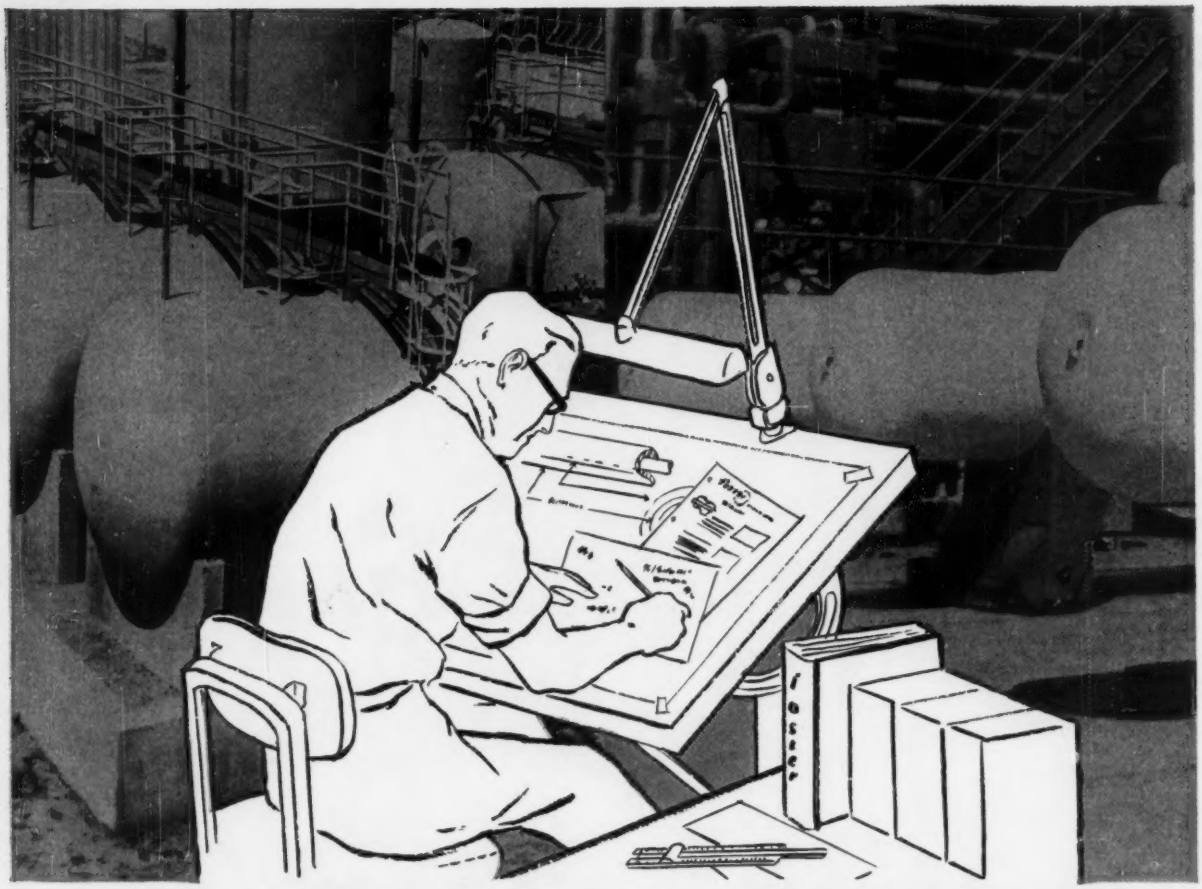
General Electric offers you the two basic elements for your automation program—the new GE 412 Digital Control Computer and the application experience necessary to get it operating efficiently in your plant.

General Electric engineers can detail the available full line of input/output equipment and computer services including SYSTEM DESIGN, PROGRAMMING and AIDS, TRAINING, INSTALLATION SERVICES, and MAINTENANCE SERVICES—offered by General Electric to get your automation program in operation quickly . . . for lower production costs, increased profits.

INVESTIGATE THE NEW GE 412—*contact your nearest General Electric Apparatus Sales Office or the Process Computer Section, Industry Control Department, P.O. Box 2918, Phoenix, Arizona.*
IN CANADA, *contact Canadian General Electric Apparatus Sales Department, Peterborough, Ontario.*
OUTSIDE THE U.S. AND CANADA, *contact International General Electric, 150 East 42nd Street, New York 17, New York.*

Progress Is Our Most Important Product

GENERAL ELECTRIC



WILL YOUR INSULATION PERFORM ACCORDING TO THE SPEC?

there's a ***foster*** *protective system to help make sure it will*

When the thermal-insulation specification includes the name "Foster," you're assured a protection system engineered to resist practically every condition the insulation can be expected to encounter. And only with the proper protection will the insulation perform efficiently.

There's no such thing as "or equal" when it comes to protecting your costly investment in insulation. Only the Foster system in the specifications can be relied on 100% to fill the bill.

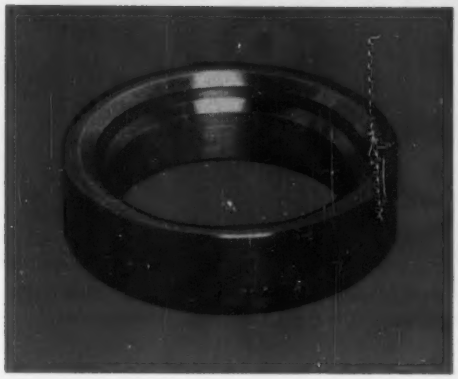
Foster insulation-protection research has developed adhesive, vapor-barrier, and coating systems to meet virtually every conceivable thermal-insulation requirement. A letter or call outlining your problem will bring one or more Foster Bulletins which should contain an appropriate solution.

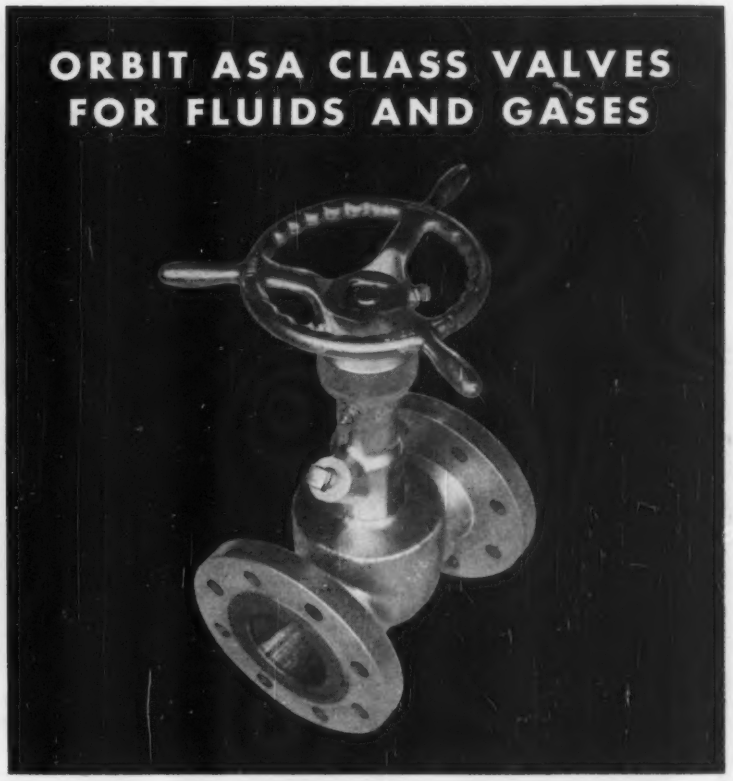
Thermal Insulation Protected By
foster
Fire Resistive
Specifications

A symbol of fire resistive construction

foster
COATINGS • SEALERS • ADHESIVES
BENJAMIN foster CO.
Division of Amchem Products, Inc.
4635 W. GIRARD AVE. • PHILA. 31, PA.

Sectional view of Orbit's Type "N" seat shows how we securely contain Teflon to prevent loss of material or cold flow and how a Teflon to metal seal is provided.





ORBIT COMBINES THE THREE BEST KNOWN SEATING PRINCIPLES IN ONE VALVE SEAT

ORBIT TYPE "N" BODY SEAT WITH MOLDED TEFLON* FEP RESIN PROVIDES:

(1) Resilient seating with metal-to-metal back-up

(2) Friction-free seating

(3) Seating without lubrication

TYPE "N" BODY SEAT HAS 400° Fahr. MAXIMUM TEMPERATURE RATING.

The convex seating surface formed by the Teflon and metal provides for absolute shut-off and assures immediate contact for positive closure. The Teflon is so contained that it is not affected by high differential pressures flowing across the seat. Normal manufacturing tolerances as well as normal valve wear are compensated for by the resilient Teflon material. Solid particles, such as line scale, dryer dust, catalyst carry over, etc. do not prevent the Orbit Valve from seating properly. Orbit's Type "N" seat provides both metal-to-metal and Teflon sealing. The metal-to-metal seat, provided by tapered metal edges, is additional assurance that seating surfaces will not be lost in case of disaster by fire. Heat treated metal seat retainer holding Teflon provides durable working surfaces.

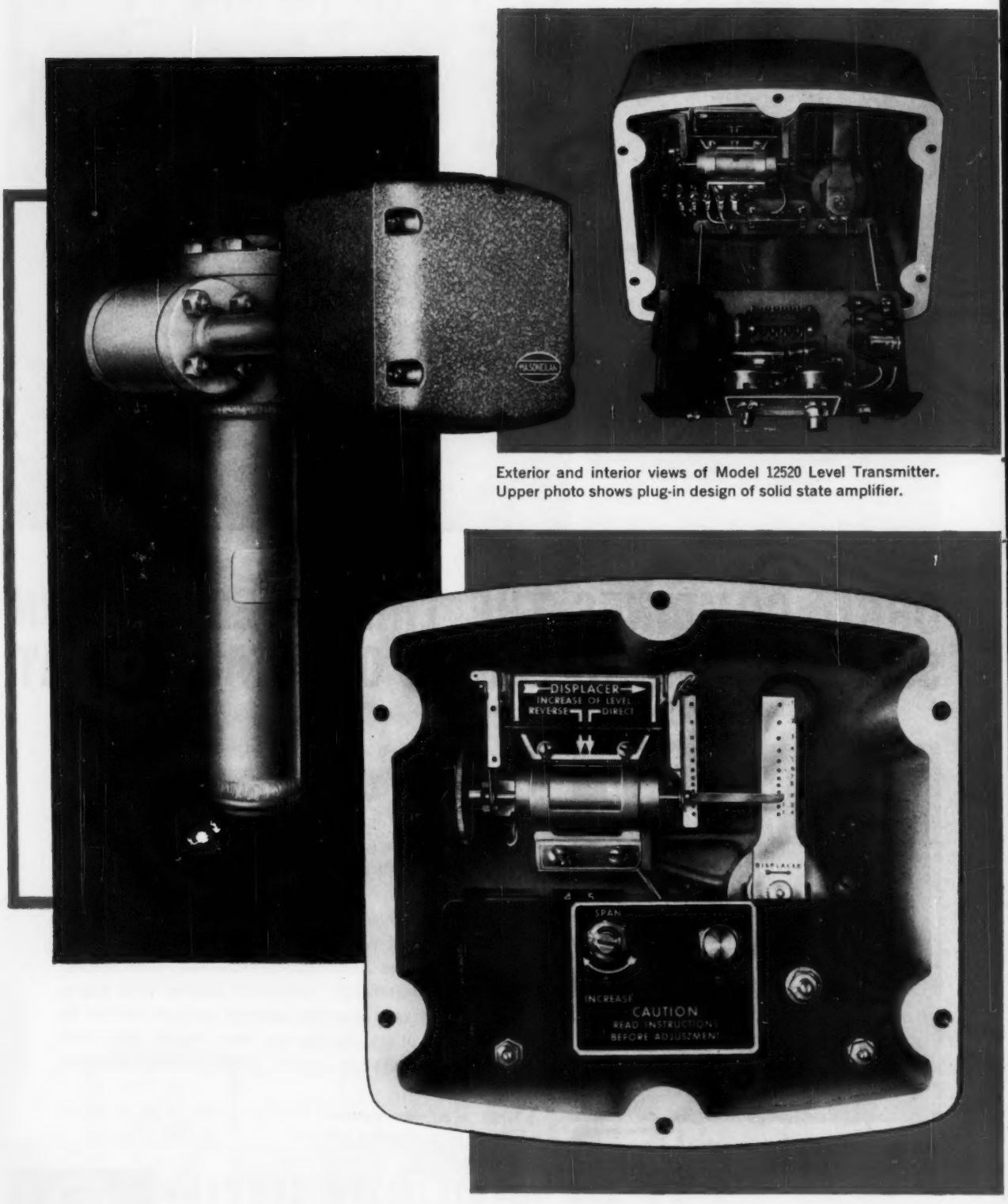
*Teflon is duPont's registered trademark for its family of fluorocarbon resins, including FEP resin.

FOR ADDITIONAL INFORMATION WRITE FOR OUR NEW CATALOG 61-B

ORBIT VALVE COMPANY
P. O. Box 699 Tulsa, Oklahoma
PHONE LUther 4-4761 TWX TU 925

ORBIT VALVES

For more data on advertised products, use cards, last page.



Exterior and interior views of Model 12520 Level Transmitter. Upper photo shows plug-in design of solid state amplifier.

Mason-Neilan Presents.....

A New High-Quality Electronic Liquid Level Transmitter

Making the proven advantages of displacement level measurement available for centralized electronic control systems

Mason-Neilan has utilized the best features of mechanical and electronic design to provide a new device for transmitting dc signals proportional to level variations.

This transmitter combines the time-tested, field-proven variable displacement measuring element made famous by the 12000 Series pneumatic level controllers, with an LVDT displacement transducer and a solid state amplifier. A choice of output signals permits use with any presently available electronic receiver — indicator, recorder or controller.

Consider these important features:

Accuracy . . . within 1%. High feedback serves to maintain accuracy and stability under changing ambient conditions. Torque tube assembly design insures true center of rotation — eliminates objectionable friction.

Reliability . . . solid state circuit with components of the highest quality.

Versatility . . . wide choice of output signals and level ranges. Left or right hand case mounting — reversible in the field. Selection of mounting types to meet all vessel requirements.

Ruggedness . . . sturdy aluminum explosion-proof instrument case provides maximum durability and protection to all internal parts.

Simplicity . . . adjustments are readily accessible and easily made. Plug-in amplifier assembly for convenient maintenance.

Complete data are yours for the asking. If you are now using, or contemplate using, electronic controls, we invite you to get in touch with a Mason-Neilan representative, or write to

MASONEILAN

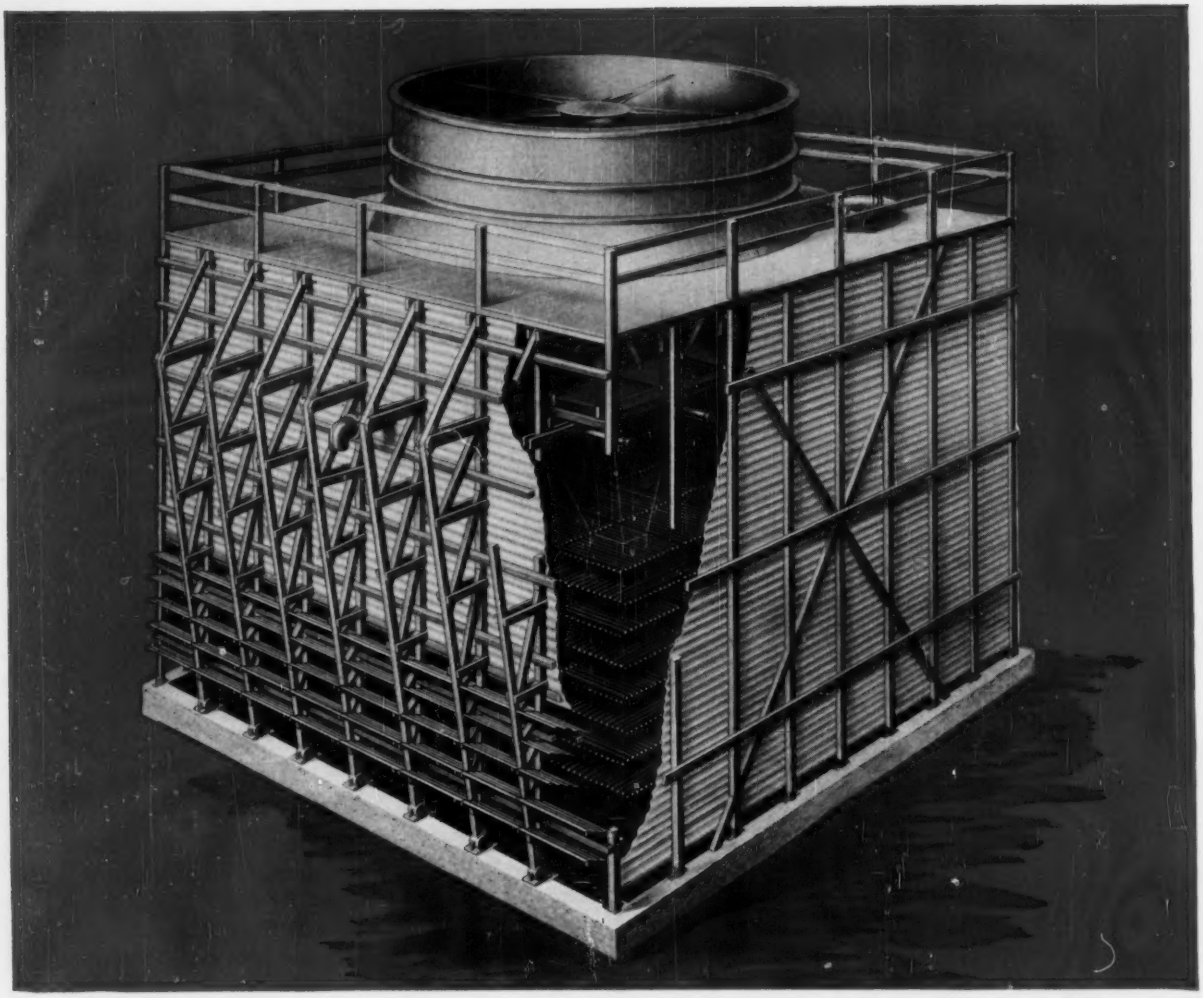
Products that Work for Your Profit

MASON-NEILAN

Division of Worthington Corporation

51 NAHATAN STREET, NORWOOD, MASSACHUSETTS, U. S. A.

MNI-16



New idea...no structural internals

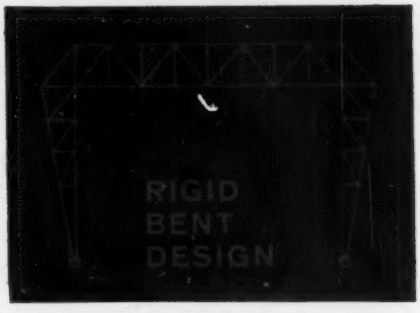
The *interior* of this new Foster Wheeler cooling tower is *completely free of structurals* below the roof trusses.

It is Foster Wheeler's new Rigid-Bent design featuring tapered built-up columns outside the tower sheathing, away from the moist, corrosive atmosphere within.

In every application, particularly where water chemistry and biological attack are serious problems, the FW Rigid-Bent design offers . . . isolation of vertical structurals from corrosion and biological attack . . . and uncommon ease of inspection, maintenance and replacement of all parts.

Space requirements and operational characteristics are the same as those attainable with older designs. Increased capacity by the addition of cells is no problem. Structurals are easily inspected and repaired during tower operation.

If you are currently considering an installation, let us provide you with further information. Write to Dept. CT, Foster Wheeler Corporation, 666 Fifth Avenue, New York 19, New York.

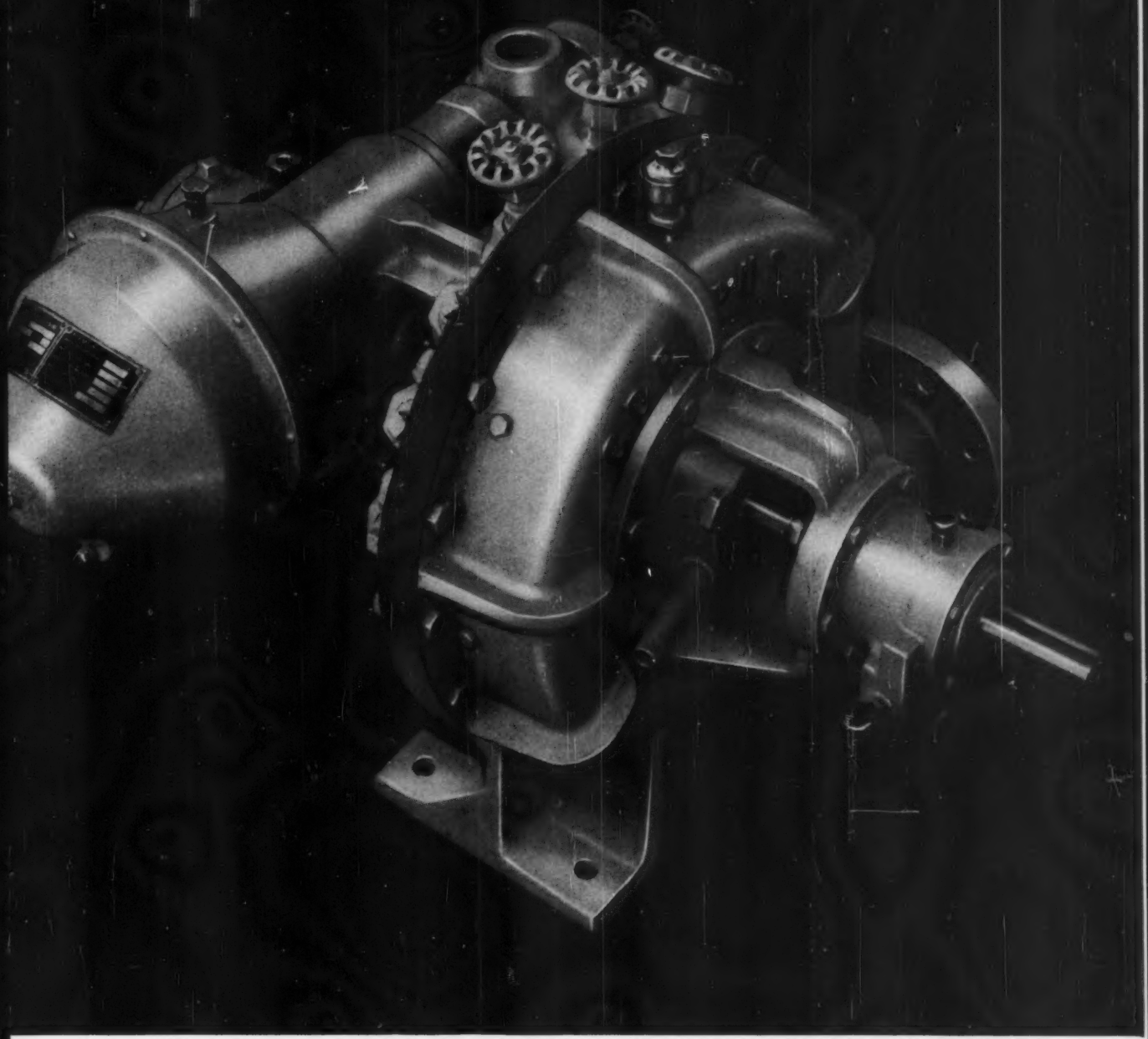


All tower internals are suspended from roof trusses. Cable-hung fill racks are quickly lowered to ground level for inspection and maintenance.

FOSTER WHEELER

NEW YORK TORONTO LONDON PARIS MILAN TOKYO

COPPUS BLUE RIBBON PRODUCTS



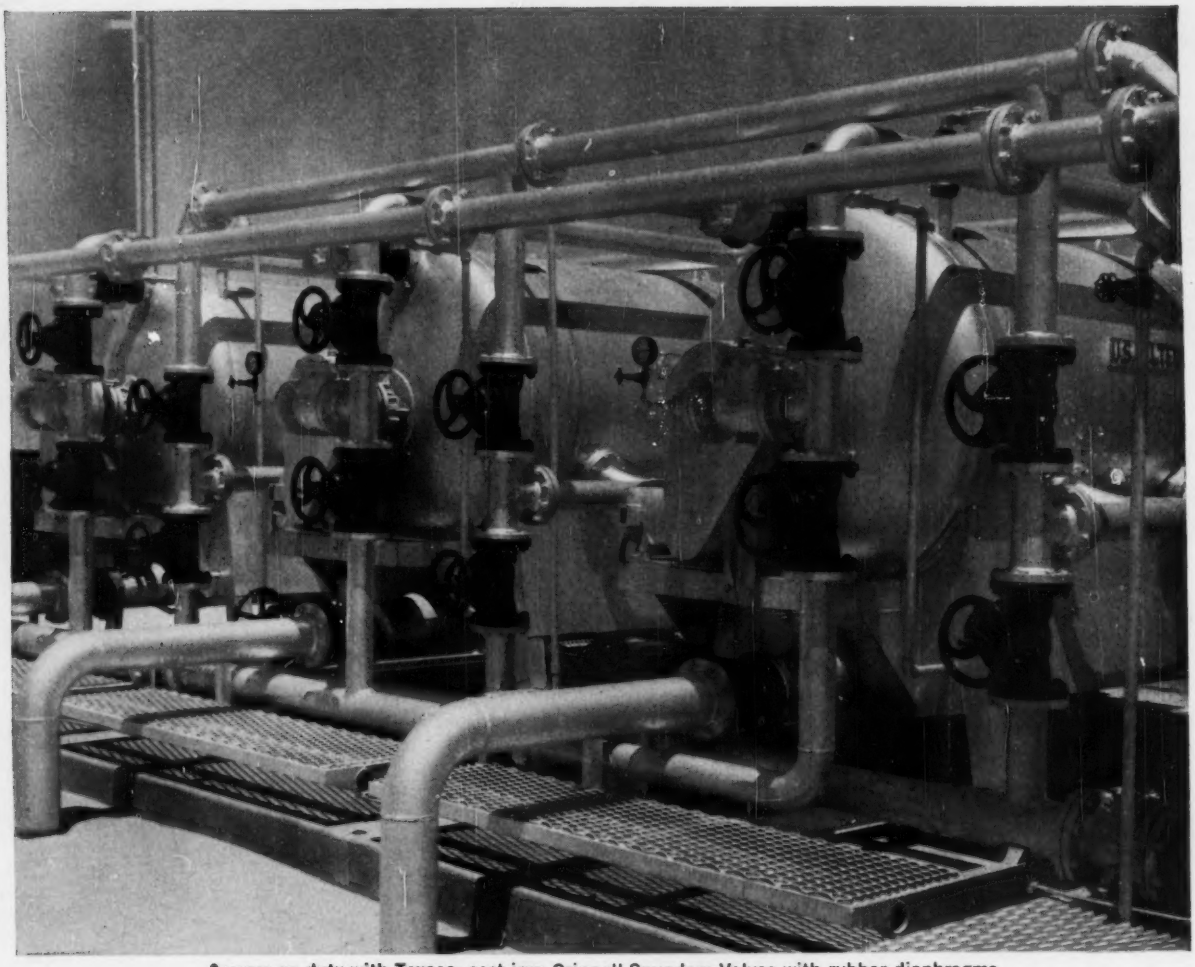
Coppus Horizontal Steam Turbine

NEW RUGGED DESIGN—BLUE RIBBON RELIABILITY!
Here's a new dimension in turbine performance! Coppus brings you a new rugged stability of design . . . a new measure of reliability in a complete range of power-packed turbines, from 1 HP to 250 HP — marked with the Blue Ribbon only after each is precision made . . . precision tested. Performance features like these assure you Blue Ribbon Reliability —

A totally enclosed governor . . . totally enclosed, independently operated safety trip . . . easily replaceable packing and bearings . . . multiple steam nozzle control . . . brake rim for added safety . . . wide bucket "L" type wheel (optional) for minimum water rate.

Coppus Turbines are built to customers' specifications, including API and NEMA standards. All Coppus Products carry the same Blue Ribbon assurance of reliable performance. For further facts on turbines, send for new Catalog 200. COPPUS ENGINEERING CORPORATION, 417 Park Avenue, Worcester, Mass. Sales Offices in *Thomas' Register*.

COPPUS
STEAM TURBINES



3 years on duty with Texaco: cast iron Grinnell-Saunders Valves with rubber diaphragms

Grinnell-Saunders Diaphragm Valves handle corrosive brine at pressures of 60-75 psi for Texaco

Valves operate easily...shut off completely...even after 3 years!

When Texaco's Kermit, Texas, plant was set up three years ago, 34 Grinnell-Saunders Diaphragm Valves were installed. Their job: handling highly corrosive brine — under pressures of 60-75 psi — for flooding wells in the secondary recovery of oil.

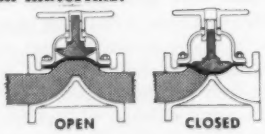
During this entire time, only *two* diaphragms have been replaced. Furthermore, all of the valves are operated at least once each week while backwashing the filter.

Grinnell-Saunders Diaphragm Valves always operate easily . . . can be shut off *completely* . . . even after years of service. Low cost maintenance is another feature of these versatile valves.

No wonder Grinnell-Saunders Diaphragm Valves are at work today throughout the petroleum industry, as well as in paper mills, food processing plants, chemical installations, and many other places!

Grinnell-Saunders Diaphragm Valves have a diaphragm that lifts high for streamline flow . . . seals tight for positive closure. Bonnet mechanism is completely isolated from material in the line to prevent corrosion and contamination. And there's a wide choice of body, lining and diaphragm materials.

Learn how Grinnell-Saunders Diaphragm Valves can help *your* installation. Write Grinnell Co., Providence 1, R. I.



GRINNELL COMPANY, PROVIDENCE 1, R. I. • BRANCH WAREHOUSES AND DISTRIBUTORS FROM COAST TO COAST
PIPE FITTINGS • VALVES • PIPE HANGERS • PREFABRICATED PIPING • UNIT HEATERS • PIPING SPECIALTIES

PORTRAIT OF DEPENDABILITY

Undisturbed cobwebs tell a powerful story! Day in and day out, OIC steel valves take strain, vibration, pressure changes and shock in their stride. From the outside you get no hint of the precise manufacturing tolerances that make this trouble-free performance possible. OIC steel valves are designed to handle your steam, chemicals or hydrocarbons with minimum maintenance and maximum cost savings. Of this you can be sure . . . OIC steel valves are built to operate with complete dependability.

THE FINEST VALVES AND DISTRIBUTOR SERVICE FROM OIC

OIC VALVES

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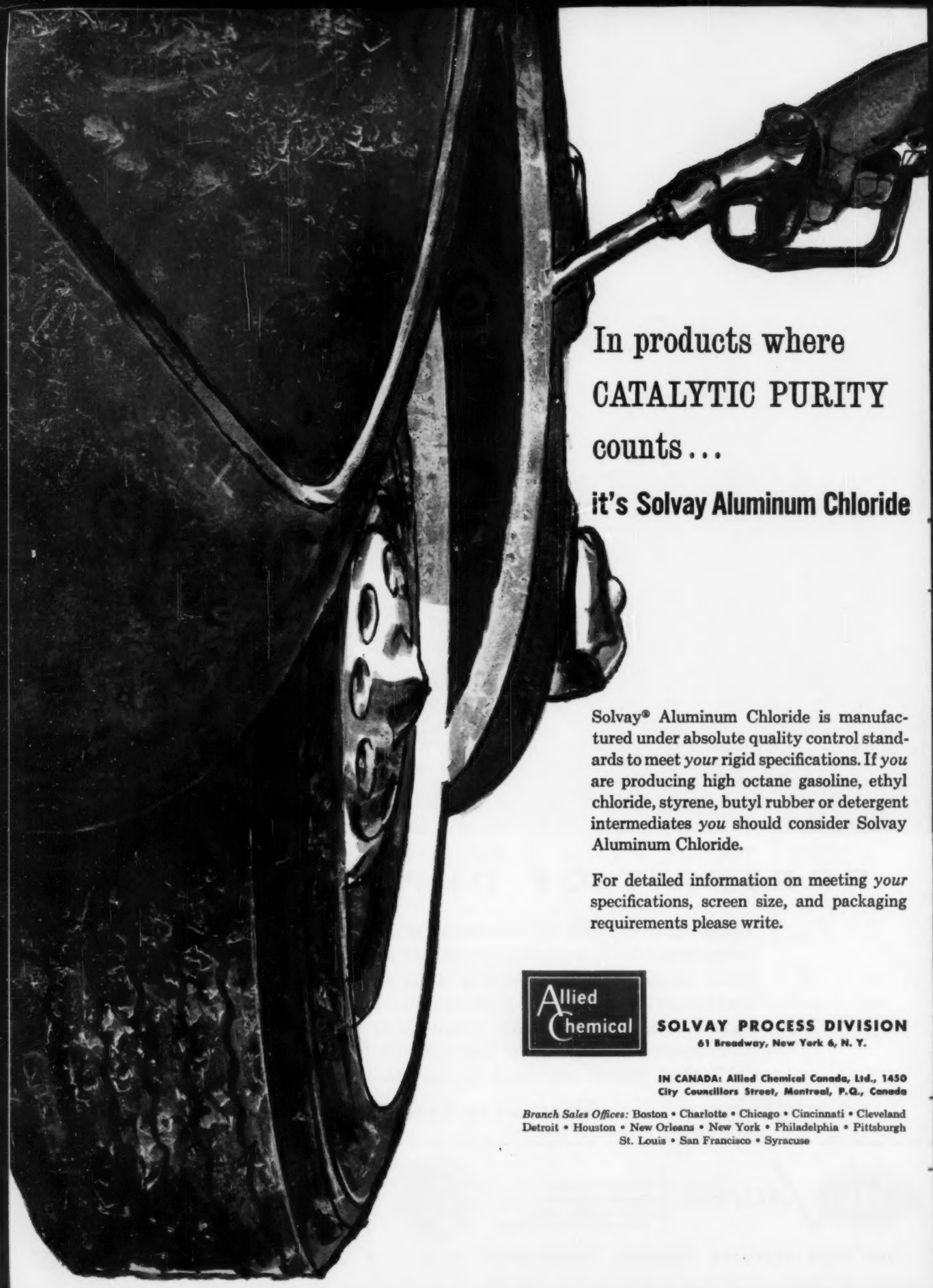

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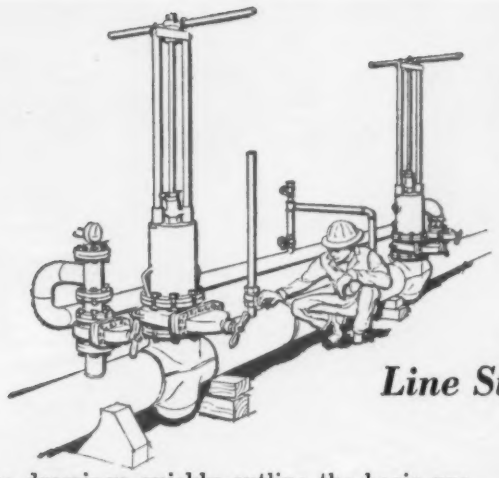
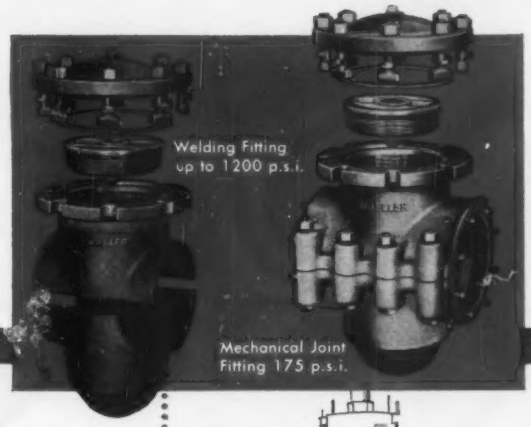


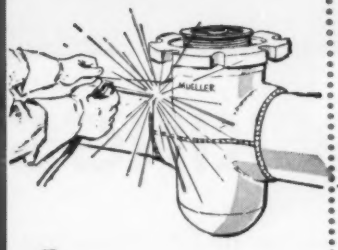
stop-off high pressure lines where there are no control valves!

here's how—with MUELLER® Line Stopper Fittings and Equipment

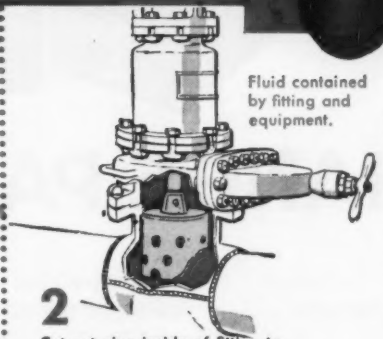
These drawings quickly outline the basic procedure used in stopping-off a line under high pressure with Mueller Line Stopper Fittings and Equipment. Line Stoppers may be used at any point on any type of line. Once installed, the fittings may be re-used for future stop-offs.

Only the major steps are shown here. Write direct for the complete story and specifications.



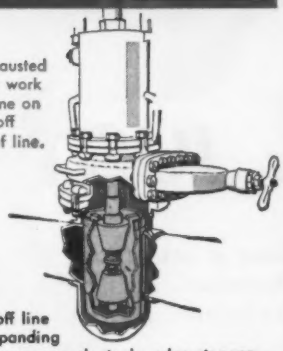


1 Weld fitting to line.



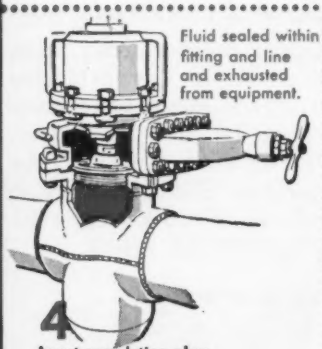
Fluid contained by fitting and equipment.

2 Cut out pipe inside of fitting to accommodate cylindrical stopper.



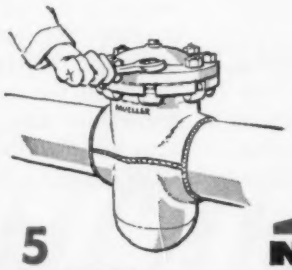
Fluid exhausted to permit work to be done on stopped-off portion of line.

3 Stop-off line by expanding neoprene-covered, steel wedge stopper.



Fluid sealed within fitting and line and exhausted from equipment.

4 Insert completion plug into top of fitting.



5 Bolt completion cap in place on fitting.

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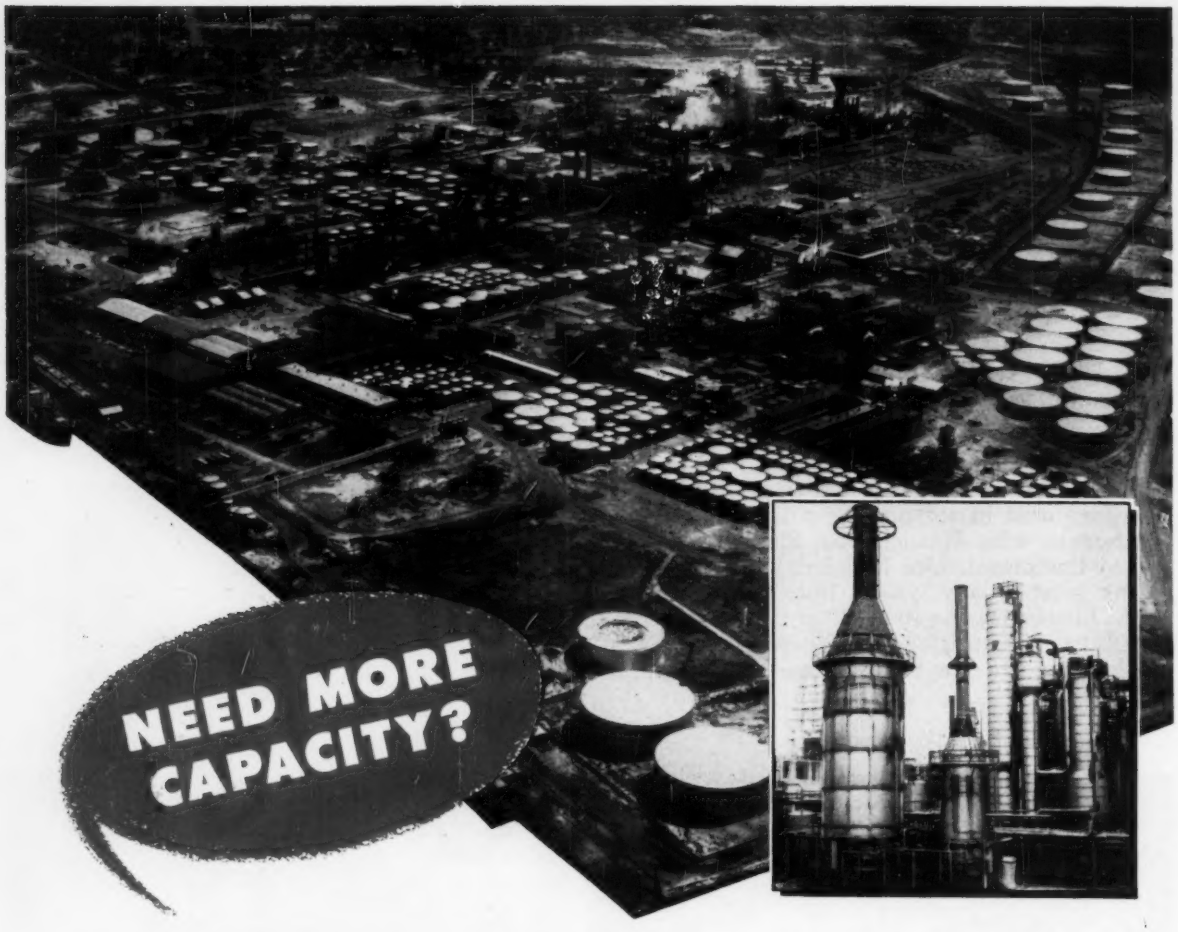

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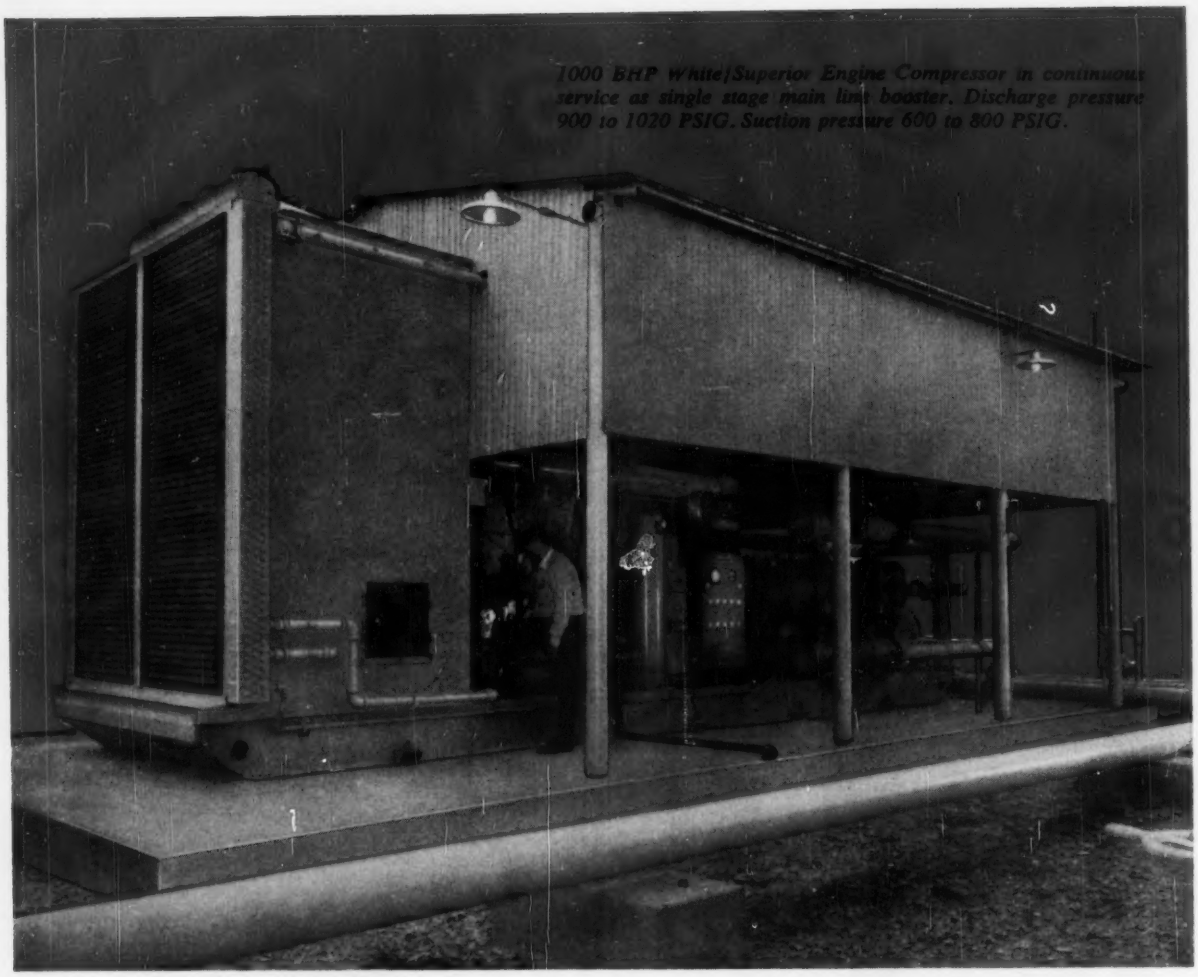

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White's medium speed, heavy duty, balanced opposed compressors—200 to 1000 BHP—are specifically engineered for direct drive combination with Superior natural gas engines or electric motors. Two, four and six-cylinder models offer cylinder sizes from 4000 PSI, 2⅝" dia. to 85 PSI, 22½" dia., providing 68 different cylinders. Custom sizes and designs are also available.

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White Diesel

A Nalco PRODUCT MANAGER Answers Questions About Refinery Desalting Practices and Economics

Apparently Efficient Desalting Operations May Be Hiding Big Operating Costs

Here are some questions about desalting that we are asked frequently in the field. Answers here are necessarily brief; but we believe Nalco has complete answers to virtually any conceivable desalting question . . . and we like to share them with refinery people . . .

Question: Why should refiners review desalting operations periodically?

Answer: Desalting can be a "sleeper" in many refineries, operating without the attention demanded by more complex processing—and sometimes doing an inefficient job that causes cumulative damage, or builds up operating costs unnecessarily. Periodic checks on desalting results and costs can be an important safeguard to overall operating efficiency.

Question: Is it reasonable to expect oil-free wash water effluent with an economical desalting operation?

Answer: Yes. Clean wash water effluent is one indication of effective desalting – but getting clean effluent does not need to indicate an expensive desalting operation.

Question: Can desalting chemicals be used with electrostatic desalting units?

Answer: Yes. They not only can be used, but with straight electrostatic desalting, results can be improved with the addition of small amounts of chemical. Nalco chemicals, for instance, have been used to treat charge stocks to electrostatic desalting equipment of all types for many years. Howe-Baker Engineers, Inc., a subsidiary of Nalco Chemical Company, designs and builds electrical desalting units; and their long, successful experience is shared by your Nalco Representative.

Question: How does Nalco treat the wide variety of crudes handled by some refineries?

Answer: Nalco's desalting chemicals are designed so that each is effective in treating a variety of crude types.

To select the best one for a refiner's present crudes (or those scheduled for future processing) screening tests are run at the refinery. Additional tests, if necessary, are performed at Nalco's desalting laboratory, using special equipment designed to reproduce actual refinery conditions.

The best chemical for the job is then chosen from Nalco's list of broad range formulas. It can be relied upon to do the best job at the lowest cost.

Question: Can Nalco chemicals increase throughput rates in existing desalting equipment?

Answer: Frequently. Whether existing equipment utilizes electrical desalting, chemical desalting, or a combination, improved chemical emulsion breaking can often speed up the desalting process . . . and, in effect, substantially increase the capacity of existing desalting equipment. In addition to boosting throughput, the use of Nalco Desalting chemicals has frequently enabled refiners to substantially reduce total chemical requirements.

Case histories in operations similar to your own may be of interest . . . and your Nalco Representative will gladly discuss them with you.

Nalco Product Manager for Petroleum Chemicals, R. C. Canapary, puts specialized knowledge to use in the field. Shown here (left) with one of the operating personnel of a large midwestern refinery, Canapary's expert assistance is an added assurance that Nalco desalting chemicals get results.

Question: Does Nalco have anything to offer where desalting is now satisfactory?

Answer: Yes: a careful check of desalting operations by a qualified expert. It may show that optimum desalting economy and efficiency is being maintained. Or it may reveal that greater economy or increased efficiency, or both, are possible. In either case, you will have an up-to-date, informed opinion of your desalting—at no cost to you.

Question: Just what does Nalco desalting service mean?

Answer: In terms of results, Nalco desalting service means continuously efficient desalting at lowest chemical costs. In setting up a desalting program, it means help from experts—in every phase of desalting technology. In terms of trouble-shooting, it means there is authoritative assistance available to you, now.

Where unusual desalting problems arise, Nalco service means the added skills and facilities of Nalco Laboratories, plus the concentrated attention of Nalco technical staff members whose principal jobs are solving special desalting problems and keeping Nalco Representatives ahead of the field in desalting know-how.

Regular testing continues where Nalco desalting chemicals are in use. The effort to better results and cut costs does not stop with the initial recommendations, nor is there the attitude of "letting well enough alone." You buy continuing *effort* and *responsibility* with every drum of Nalco chemical.

Why not put Nalco's expert desalting service to work for you today?

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HELPFUL WATER CONDITIONING DATA FROM BETZ

NEW ADVANCES IN ION

The development of ion exchange resins in the past few years has opened up broad new fields of scientific and industrial applications.

At the present time the field of ion exchange is in a state of rapid change and advancement. New resinous exchange materials are appearing with increasing rapidity, and it is sometimes difficult to keep abreast of the volume of technical papers on the many new developments. The application of ion exchange resins in such fields as pharmaceuticals, chemical processing, metal recovery, water softening, etc. is almost limitless. The development of ion exchange resins for use in the field of water treatment has been phenomenal and has contributed much to the technology of water treatment. A variety of water treatment processes have been the result, such as those listed in Figure 1.

1. Sodium Zeolite Softening
2. Cation Exchange by Hydrogen Zeolite
3. Hot Lime—Hot Ion Exchange Softening
4. Demineralization
5. Demineralization with Silica Removal
6. Dealkalization by Chloride—Anion Exchange

Figure 1—Ion Exchange Processes

History of Ion Exchange

The natural phenomenon of what now is called ion exchange was observed many centuries ago. It is generally recognized that the first formalized studies were conducted about 1850 and involved ion exchange properties of soils. These early studies concluded that ion exchange was not the same as physical absorption, but that equivalent quantities of ions were exchanged and that the materials in the soil making the exchange possible were the aluminum silicates.

Subsequently, considerable work was done on the silicates, both natural and synthetic. However, it was not until about 1900 that any significant commercial use was made of these exchange materials. While commercial applications of the siliceous exchangers increased, they were limited almost solely to hardness removal. The principal exchange materials were the greensands, although the synthetic silica gels occasionally were used. Somewhat later carbonaceous zeolites (sulfonated coal), capable of being operated on the sodium or hydrogen cycle were developed. The introduction of exchange materials that could be regenerated by acid to accomplish both hardness and alkalinity removal markedly increased the field of application of ion exchange processes for the treatment of water. Carbonaceous exchange materials are still employed on the hydrogen cycle, but their use on the sodium cycle has been supplanted by resins which have better regeneration efficiency and much higher exchange capacity.

Ion Exchange Resins

The first commercially available ion exchange resins were introduced in the late 1930's. The cation exchange resin was a condensation product of phenolsulphonic acid and formaldehyde. The anion exchange resin was a condensation product of polyamines and formaldehyde. Since that time there has been much improvement in stability and versatility of resins. Most resins produced today are prepared by copolymerization of styrene and divinyl benzene. The divinyl benzene has the effect of cross-linking the polystyrene, increasing both the stability and density of the copolymer. Before the copolymer can be used as an ion exchange resin, reaction groups must be added to the copolymer. The functional groups, which are attached, determine whether the resin will be a cation or an anion exchanger.

The types of ion exchange resins that are most widely used in water treatment are:

1. Strongly acidic cation exchange resins
2. Strongly basic anion exchange resins
3. Weakly basic anion exchange resins

The strongly acidic resins in commercial use are sulfonated copolymers of styrene-divinyl benzene, and the functional or active exchange sites are the sulfonic acid group (SO_3H). This resin is widely used on the sodium cycle (regenerated with sodium chloride) or on the hydrogen cycle (regenerated with acid). The resin is very stable and can be used at elevated temperatures up to 250 F. on the sodium cycle.

The strongly basic resins are of the styrene-divinyl benzene copolymer type with the functional sites being quaternary ammonium groups. Strongly basic resins are manufactured in two forms: Type I and Type II. The Type II functional groups have an ethanol group substituted for one of the methyl groups. The essential differences are that the Type I has better chemical stability and Type II has a better regeneration efficiency in the hydroxyl form.

The strongly basic resins are highly ionized and have the ability to remove weakly ionized substances such as silica and carbon dioxide as well as strong acids. These resins were first used commercially about 1948, and with their introduction the production of mineral free water by ion exchange became practical.

The weakly basic anion exchange resins utilize the copolymer of styrene and divinyl benzene. These resins are the polyamine type and the functional exchange sites are primary, secondary and tertiary amine groups. They are used mainly for the removal of strong acids. In practice, they are used as anion exchangers following strongly acidic cation exchangers in demineralization systems when the removal of silica is not essential. They have a somewhat higher exchange capacity and a better regeneration efficiency than the strongly basic resins.

Water Treatment Processes

It is possible with the water treatment processes listed in Figure 1 to select a method or combination of methods that will prepare a water to meet requirements for use over the complete range of boiler pressures. Figure 2 illustrates a typical raw water and the analysis of the water after treatment by some of the processes listed in Figure 1.

The effluent of Process 1 produces almost complete hardness removal leaving the other constituents unchanged. Process 2 removes both hardness and alkalinity and produces free mineral acid (FMA) equivalent to the sulfate and chloride content of the water. The combination of Processes 1 and 2 serves to neutralize the free mineral acid and to restore a portion of the alkalinity.

Process 3a shows the characteristics of the water after lime softening in the hot while Process 3b is the effluent after

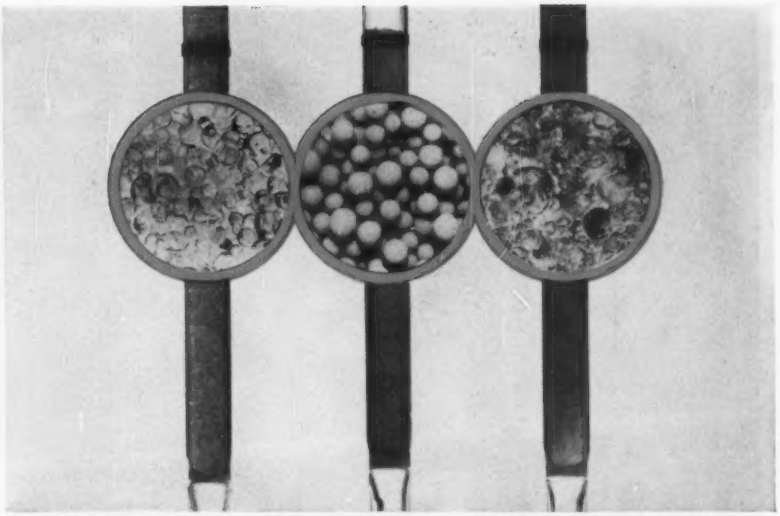

Figure 3—Betz INX-30 resists oxidants. The three columns were filled to the same level with two standard cation exchange resins and Betz INX-30. Exposed to 3% hydrogen peroxide, the standard exchangers swelled and showed severe physical damage; Betz INX-30 was unaffected except for a slight bleaching of color.

EXCHANGE RESINS

	Raw Water	1	2	1 + 2	3a + 3b		5
Total Hardness	150	0-2	0-2	0-2	18	0-2	0
Calcium as $CaCO_3$	110	0-1	0-1	0-1	15	0-1	0
Magnesium as $CaCO_3$	40	0-1	0-1	0-1	3	0-1	0
Alk. (P) as $CaCO_3$	0	0	0	0	13	13	0
Alk. (M) as $CaCO_3$	100	100	0	20	20	20	2
SO_4	40	40	40	40	40	40	0
Cl	10	10	10	10	10	10	0
SiO_2	15	15	15	15	3	3	.02
FMA			55				
Specific Cond. mmhos.							1.0
NOTE—results in ppm							

Figure 2—Typical Softener Processes

passing through ion exchange on the sodium cycle. Hardness, alkalinity and silica reduction have occurred. Finally, Process 5 provides complete demineralization, including silica removal.

The final selection of the process to be used will depend on the intended use of the water to be treated and the economics of the treatment costs, equipment costs and other factors.

Stability of Resins

The newer ion exchange resins are rugged materials which can operate over a wide range of pH, temperature, water characteristics and flow rates. They are far more stable than the natural greensands and synthetic zeolites. Many of the problems encountered with the older type materials can best be solved by replacement with these newer high capacity resins. While the newer resins are very stable they are not immune to fouling, mistreatment and deterioration. These resins must be applied within the limits specified and must be given proper care.

Copolymer chemistry, which has been responsible for the development of these more stable resins, has advanced to the point where resins can be more or less tailor-made to suit many applications. For example, a new resin identified as Betz INX-30 recently has been introduced. This high capacity, strongly acidic cation resin has physical and chemical stability unmatched by any previous cation exchange resin. Betz INX-30 is particularly recommended for applications where chemical or physical instability of standard cation exchange resins has resulted in short resin life.

Your Betz Field Engineer will be pleased to discuss the application of ion exchange, the care and operation of the units and these new developments.

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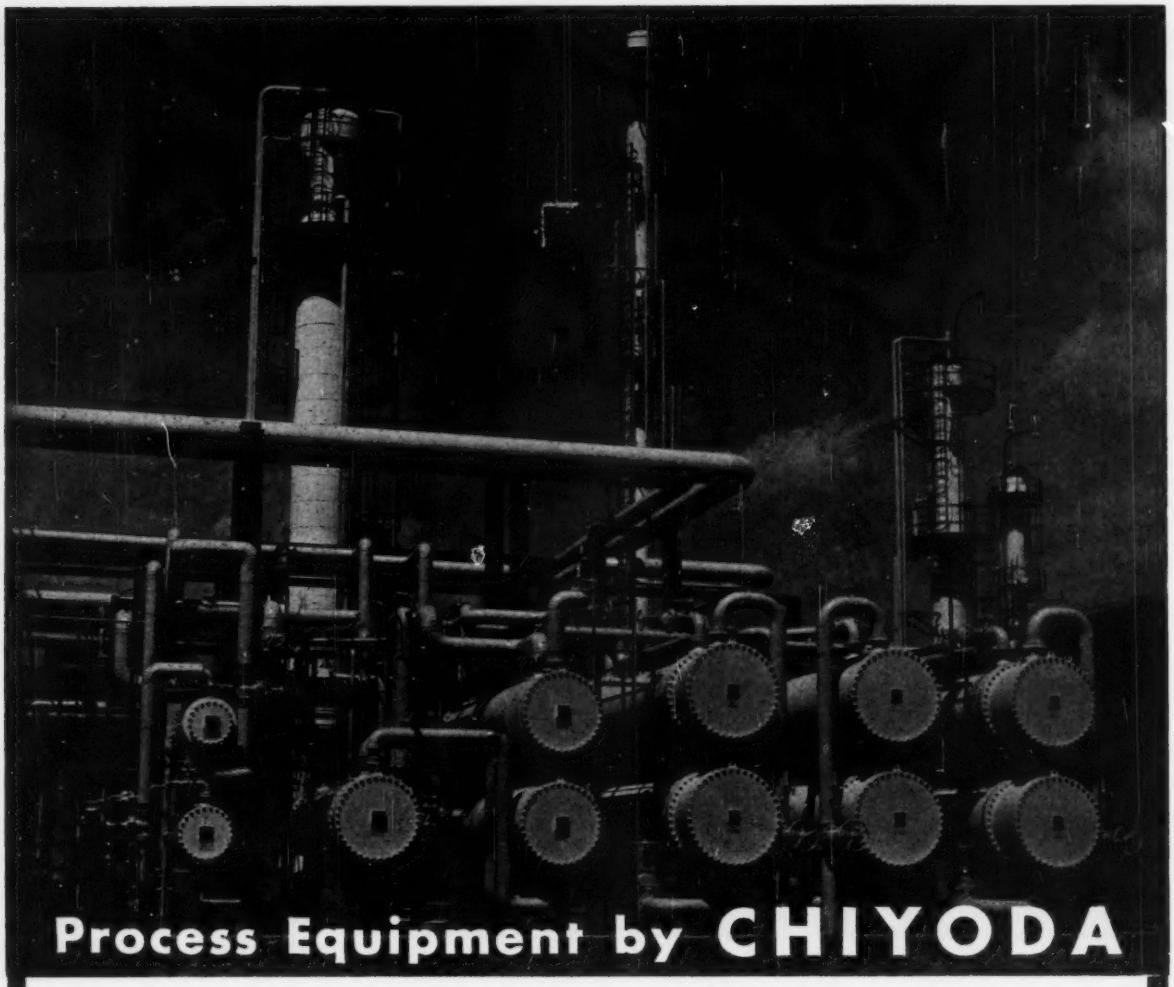

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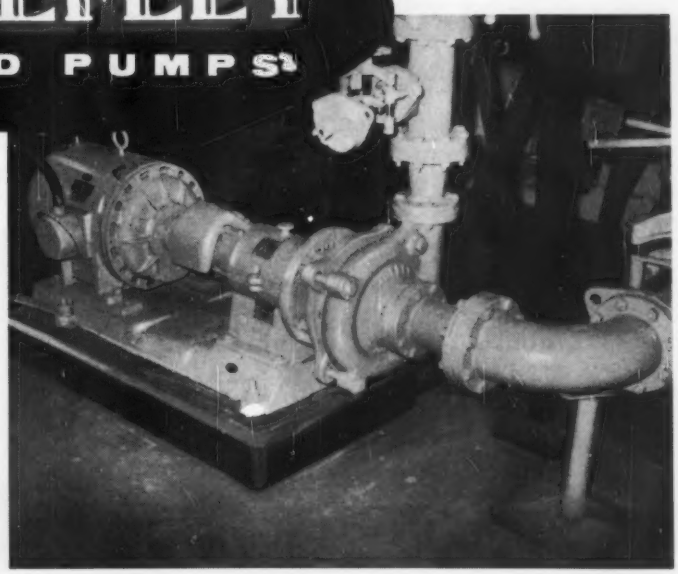

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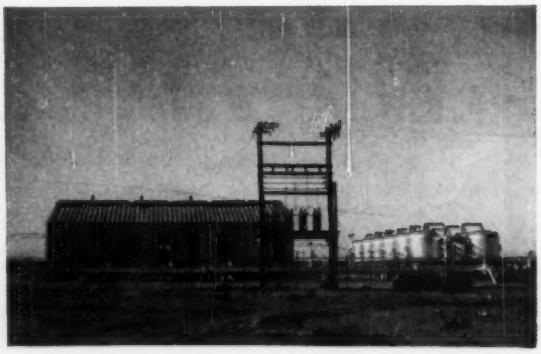

seal

CONSOLIDATED SAFETY RELIEF VALVE'S Sealing Bellows protects against damage from contaminants, corrosion, or viscous fluids

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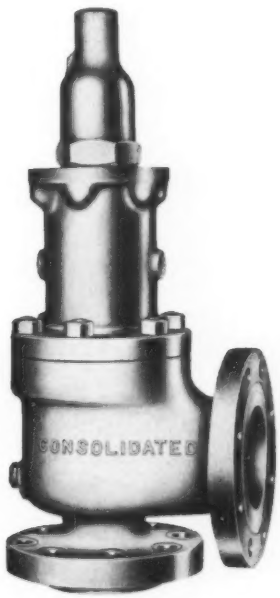

Consolidated Safety Relief Valves are available in both Balanced Bellows and Standard designs. The Standard type has an eductor tube that effectively removes bonnet pressure.

Balanced Bellows Type Consolidated Safety Relief Valves have a durable, two-ply stainless steel Sealing Bellows that isolates and protects working parts from destructive elements in the lading fluid.

The bellows is balanced with the seating surface. Even with superimposed back pressure in the relieving system, valve performance is consistently stable and dependable. The bellows does not affect the high capacity of the valve, nor does it require change in set pressure. Even the blowdown adjustments are limited.

Additionally, Consolidated Safety Relief Valves now offer a no-leak tightness maintained by a resilient "O" Ring Seat Seal retained in the valve disc. This Seal assures tightness at operating pressures far closer to set pressure than with metal-to-metal seats alone, yet does not carry the seat load imposed by the spring. The Seal also takes piping strains much better than all-metal seating.

The Sealing Bellows and "O" Ring Seat Seal are typical of the extra quality built into Consolidated Safety Relief Valves to assure absolute protection for personnel and plant. These fine features plus flat seating and single ring construction also eliminate many maintenance problems and costs. Write for Catalog 1900 and Bulletin 1940.

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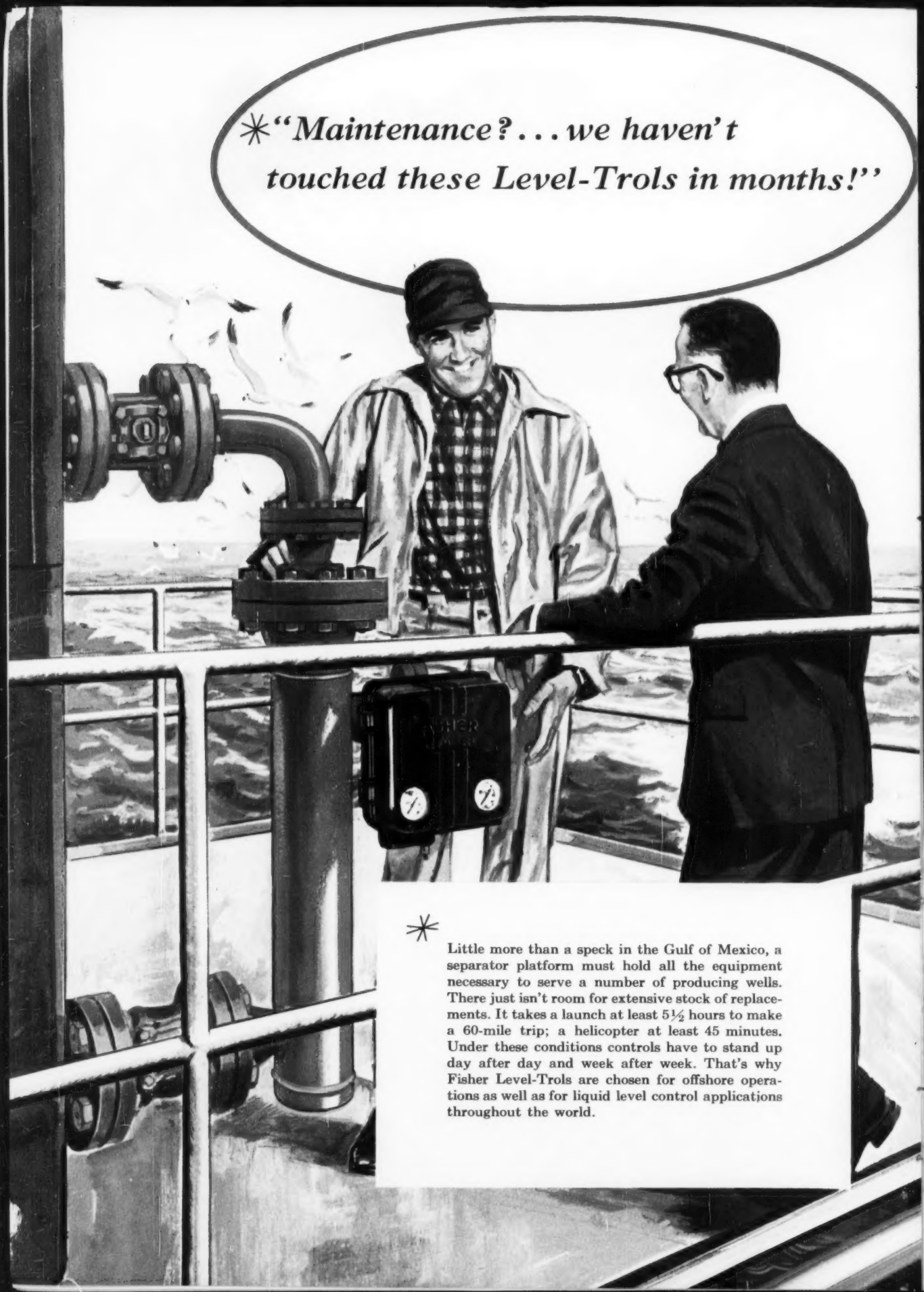

*

Little more than a speck in the Gulf of Mexico, a separator platform must hold all the equipment necessary to serve a number of producing wells. There just isn't room for extensive stock of replacements. It takes a launch at least 5½ hours to make a 60-mile trip; a helicopter at least 45 minutes. Under these conditions controls have to stand up day after day and week after week. That's why Fisher Level-Trols are chosen for offshore operations as well as for liquid level control applications throughout the world.

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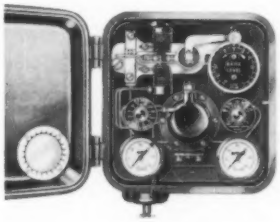
for accurate, trouble-free liquid level control on a wide range of applications . . . .

THREE BASIC CONTROLLERS

THE POPULAR TYPE 2500 PROPORTIONAL CONTROLLER—This compact and economical liquid level controller provides a proportional band adjustment up to 100%. It is pneumatically operated and level position is manually adjustable for quick, simple selection of set point. The 2500 is suitable for 3 to 15 psi or 6 to 30 psi output ranges. Controller action easily reversed in the field. Available in all styles of mountings and housings and in displacer lengths 14″ through 120″.



TYPE 2502 PROPORTIONAL RESET CONTROLLER—This Level-Trol includes, in the same size case, all the features of the Type 2500, plus reset action. It, therefore, brings the set point back, automatically to its original position and assures absolutely stable control. Proportional band adjustable to 200% and reset rate is adjustable from .005 to 1 minute per repeat.

TYPE 2300 ELECTRONIC CONTROLLER—Explosion-proof design for hazardous locations. External adjustments for proportional band (10 to 100%) and liquid level set point. Mounts on standard Level-Trol housings. Available for output DC signals 1 to 5 ma, 4 to 20 ma or 10 to 50 ma. Has plug-in converter with printed circuit. For more information on Fisher Level-Trols write to:

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Marshalltown, Iowa / Woodstock, Ontario / Rochester, England

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If it flows through pipe anywhere in the world ...chances are it's controlled by.....

FISHER® Controls SINCE 1880

Stresses can't concentrate because threads are continuous in Bethlehem studs

Why continuous threads mean long life at low cost: This Bethlehem continuous-thread stud has no point of thread run-out, making it impossible for stresses to concentrate at any specific area. Instead, stresses tend to be distributed over the stud's full working length. Long service life, low maintenance, and reduced cost are the obvious results when you use Bethlehem continuous-thread studs.

Bethlehem makes a special nut for every application: For use with Bethlehem continuous-thread studs, choose from these four grades of specially engineered nuts:

Grade 2—moderately high temperatures and pressures
Grade 2H—higher temperatures and pressures
Grade 4—severe temperatures and pressures
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Each nut meets ASTM Specification A-194. And each comes in the full size range.

Bethlehem continuous-thread studs and quenched nuts are available for a wide variety of refinery applications. For more information call the nearest Bethlehem sales office, or write to us at Bethlehem, Pa.

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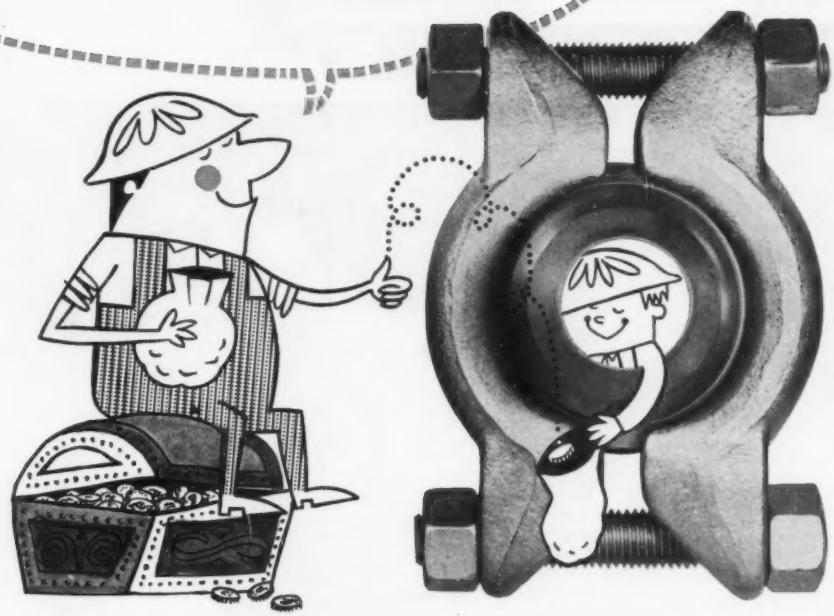
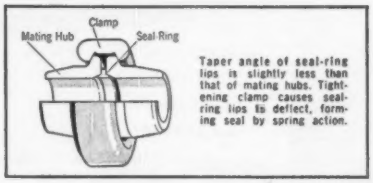
How Grayloc® Pipe Connections Can Save You Money




Clamp
Mating Hub
Seal Ring
Taper angle of seal-ring lips is slightly less than that of mating hubs. Tightening clamp causes seal-ring lips to deflect, forming seal by spring action.

Money isn't always measured in dollars — around a shop or plant it may be disguised as space, time, effort, weight, trouble and inventory. With GRAYLOC Pipe Connections, you're saving in all these categories.

Specifically, GRAYLOC Connections are smaller than equally rated flanges so they weigh less. With only two bolts per connection, they take less time, trouble and effort to assemble.

The completely re-usable, all metal seal ring eliminates the need for replacement gaskets, so you save again on inventory and on maintenance time. Fluctuating temperatures and pressures, external stress or vibration never lead to loose, leaky GRAYLOC Connections. After they're assembled, they never need re-tightening.

GRAYLOC Connections are manufactured in standard stock sizes from 1″ to 30″, with special sizes available on request. They can easily be made of corrosion resistant metals on short notice. To learn the complete, validated GRAYLOC story, write today for the GRAYLOC catalog.

GRAYLOC SALES DIVISION

GRAY Tool Company

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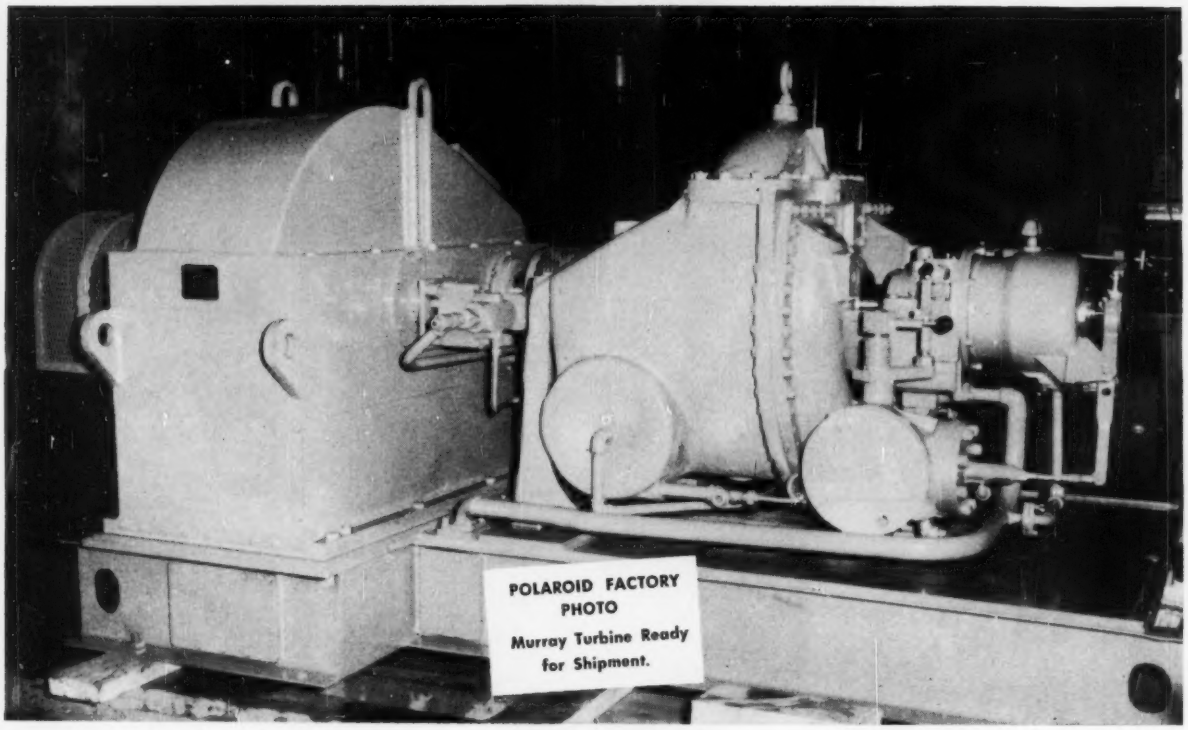
For more data on advertised products, use cards, last page.

Murray
TURBINES



Murray Type U Mechanical Drive Turbine and Gear, 1200 HP @ 4300/880 RPM. Steam Conditions are 580 PSIG, 700°, 75 PSIG Exhaust.

Murray Iron Works Company Turbines are built to stand up for many years of trouble-free economical operation. Each unit is engineered to the highest standards. Spare parts fit properly as received from the factory regardless of the number of years the turbine has been in service.

What better proof of the attention to detail both in engineering and shop craftsmanship?

The true economy of Murray Turbines speaks for itself after years of trouble-free operation. Write today for information on Murray Turbines to meet your requirements.

Murray
IRON WORKS COMPANY
BURLINGTON, IOWA

Builders of Steam Power Equipment for Nearly a Century

need help on foaming problems?

If you operate a gas treating unit using ethanolamines or ethylene glycols, chances are foam is nothing new to you. It's not necessarily a sign of trouble. But if foam is too stable, you may soon be up to your ears in foaming problems.

What to do: Proper care of the amine or glycol solution is the best cure for foaming problems. Start with materials of guaranteed purity, ethanolamines and ethylene glycol from Allied Chemical.

- In amine systems, first preventive steps are proper reclaimer operation and adequate filtration – using activated charcoal, in some cases, to adsorb foam-generating materials.
- In glycol systems, first steps are proper pH control, adequate filtration and provision for good separation of hydrocarbons and glycols.

How to rate your unit on foam: Bubble air through a 50-ml. sample of plant solution in a graduated cylinder, using either a medium or fine fritted glass dispersion tube. You'll need a means of measuring air flow so rates will be reproducible. Use two or three rates—e.g., .03, .05, and .10 cu.ft./min. Both at room temperature and at about 50°C (122°F), observe:

1. Type foam formed (bubble size, apparent consistency).
2. Time required for foam to reach maximum height.
3. Time required for foam to break after air flow is stopped.

Repeat same test on equivalent amine or glycol solutions made up from fresh, unused amine or glycol and compare results. If the plant solution has an appreciably greater tendency to form stable foams of uniformly large bubble size, get ready for trouble.

What about foam inhibitors: Remember, these don't solve the basic problems, but merely give control until you locate the cause of the foam and correct it. Also, how they act may depend on whether they are added *before* or *after* the foam is generated.

For more help, write for "Report on Foaming Problems". We'll also be glad to send you technical data, delivery and price information on Allied Chemical Ethanolamines and Ethylene Glycols.

For specs and local offices, see Chem. Materials Catalog, page 272A; Chem. Week Buyer's Guide, page 27. 2819

Allied Chemical

BASIC TO AMERICA'S PROGRESS

NITROGEN DIVISION

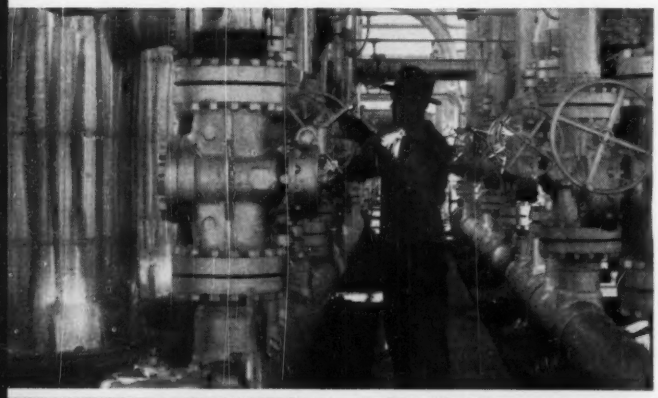
Dept. GA 6-21-1, 40 Rector St., New York 6, N.Y.

FARROWTEST REJECT TABLE

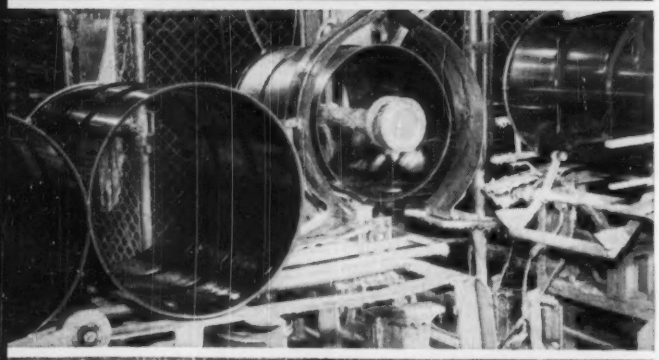
Wall Thickness (B.W. Gage)	Minor dimension of the defect (Length or Depth)	Defective Area (Length, Depth Plane)
20	.006"	.0025 sq. inches
18	.006"	.003 sq. inches
16	12½% of wall	.003 sq. inches
14 and 13	12½% of wall	.004 sq. inches
12 and heavier	12½% of wall	.005 sq. inches

FARROWTEST detects and rejects not only tubing containing defects which completely penetrate the wall; but also tubing with defects equal to, or greater than, those shown in this table. For irregular defect shapes, a tube with defect area equal to or greater than shown above is rejectable. Where required, sensitivity of FARROWTEST equipment can be calibrated to reject defects of lesser specified area than shown in table, at extra cost.

FARROWTEST—QUALITY YOU CAN MEASURE. Not a laboratory theory, not a mere inspection tool, but an exclusive final production test that detects and rejects tubing containing defects of critical size. FARROWTEST is offered as an alternative to other less positive tests in accordance with the table above at no extra cost.



ALLOY STEEL STUDS made by Republic are characterized by accurate, full formed threads. Usually furnished in AISI 4120 Chrome-Moly Steel, heat treated to ASTM A193, designation B-7, or in designations B-14 and B-16 for higher temperatures. Precision heat treatment during manufacture reduces the danger of creep, stretch, or fatigue failure. Send for booklet listing types, sizes, and complete specifications.



ELECTROSTATICALLY LACQUERED DRUMS available from Republic assure peak protection for your product. In Republic's ELECTRO-LAC Process, a fine lacquer mist is dispersed from a high speed distribution head. This mist is uniformly attracted (as a result of an electrostatic field produced in the drum) over the entire interior. Thin spots in the coating are eliminated. Ask your Republic Container salesman for details or mail the coupon.

REPUBLIC SRK® PLASTIC PIPE can save time and money in many oil field jobs. SRK is resistant to crude oil, brine, and sour gas. It costs no more than ordinary pipe, and installation is extremely fast. Available in sizes from ½" through 8", SRK is a semi-rigid plastic pipe that can be cut with a handsaw. It is joined with solvent welded plastic fittings and can be installed in combination with existing metal lines. Mail coupon below.

Republic ELECTRUNITE

HEAT EXCHANGER TUBING

by FARROWTEST

as a "FINAL" test after processing

Increasing pressures and more critical applications in the petroleum industry demand that heat exchanger tubing meet highest performance standards—for extended periods of time.

FARROWTESTED Republic ELECTRUNITE Heat Exchanger Tubing assures that these standards will be met and exceeded. FARROWTEST is Republic's exclusive nondestructive eddy-current test.

ELECTRUNITE offers quality you can measure. Every length of FARROWTESTED ELECTRUNITE has been proven by the ultimate in nondestructive production line testing. This is a *final* test, made in accordance with table at upper left, after *all* mill processing has been completed.

Carbon steel heat exchanger tubes are produced to ASTM specifications A-214; stainless tubes to A-249. Both specifications include nondestructive clauses permitting eddy-current testing—FARROWTEST. And Republic offers FARROWTEST as an alternate to other less positive tests at no increase in cost.

Get full information on FARROWTESTED ELECTRUNITE Heat Exchanger Tubing—the tubing in tune with today. Call your Republic representative or write direct.

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Dependable

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- ☐ ELECTRUNITE® Heat Exchanger Tubing
- ☐ Alloy Studs
- ☐ SRK Plastic Pipe
- ☐ ELECTROSTATICALLY Lacquered Drums

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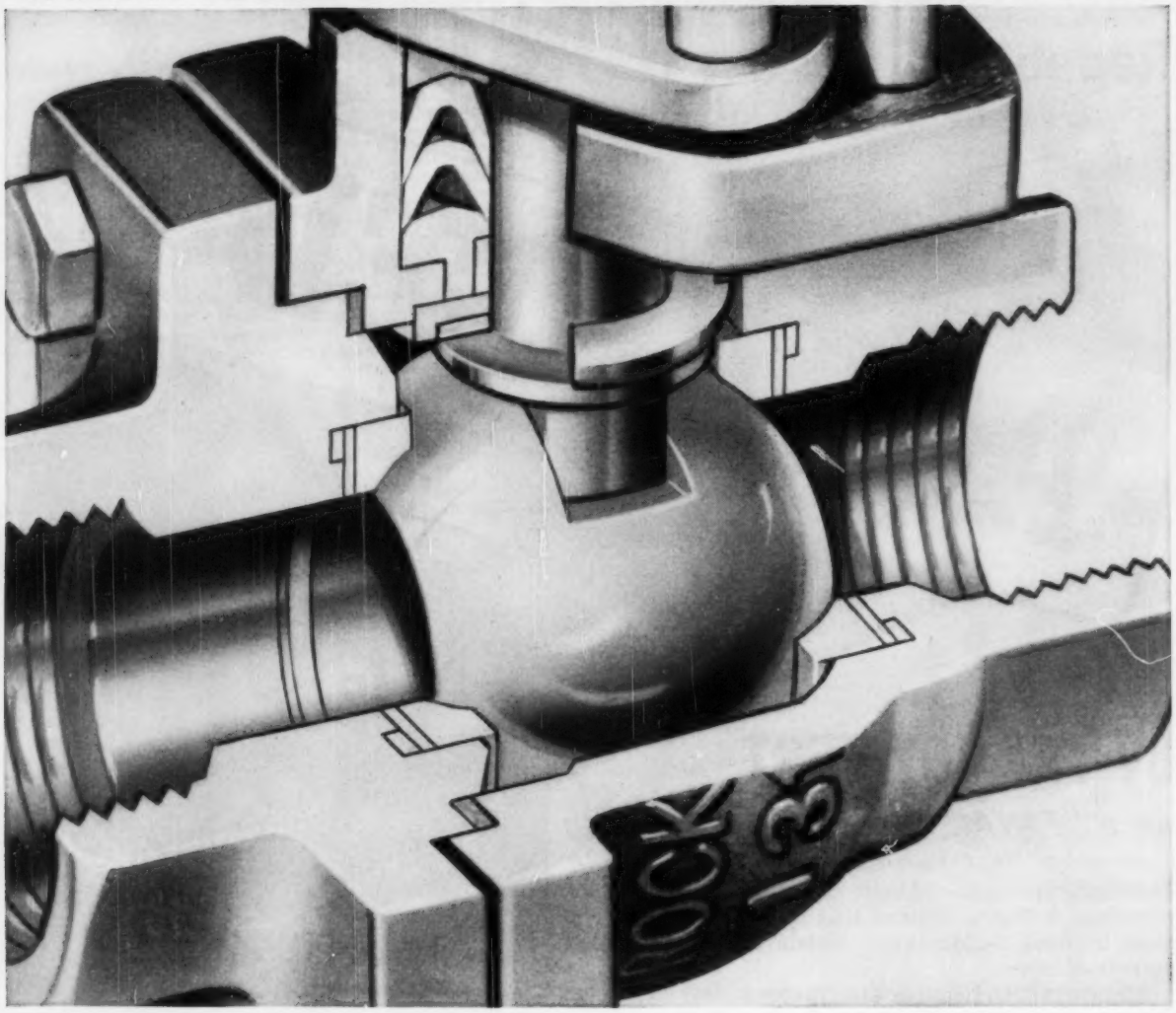
TAKE A CLOSE LOOK AT ROCKWOOD BALL VALVES



Why look for spring-loaded ball seats?

Here are the important reasons. Spring-loaded ball seats are the only kind you can depend on for long-term, tight sealing. Ordinary ball seats wear with use, become loose, leaky and imbedded with foreign particles.

That's why *every* Rockwood Ball Valve has seats with conical springs that automatically compensate for wear, pressure changes and temperature effects. The spring's constant, even pressure against the entire seat keeps it tight against the ball . . . for positive, lasting, leak-proof service through thousands of turns.

And Rockwood Ball Valves have these other important advantages:

Larger waterway diameters for lower pressure loss.

Wider choice of casting materials, mounting styles, operating methods, ball seat materials — in pipe sizes from ⅜" to 14".

Time-proven dependability. Rockwood was the first to manufacture a commercial ball valve, which still sets the standard of quality in ball valve design.

Get the complete details from your Rockwood man or write Rockwood Sprinkler Company, Ball Valve Department, 253 Harlow Street, Worcester 5, Mass. Distributors in all principal industrial areas. Rockwood Sprinkler Company, A Division of The Gamewell Company, A Subsidiary of E.W. Bliss Co.

ROCKWOOD

BALL VALVES

This compact Package Air Preheater is being installed on a 150,000 lb/hr boiler at Olin Mathieson Chemical Corp.'s Brandenburg, Kentucky, petrochemical plant. When in operation it will recover enough heat from the boiler exhaust to increase efficiency of the boiler between 8% and 9%.

OLIN MATHIESON RECOVERS 360°F FROM BOILER EXHAUST WITH 11½' x 11' x 8' PREASSEMBLED LJUNGSTROM® PACKAGE AIR PREHEATER

Olin Mathieson specified a Ljungstrom Package Air Preheater because it saves space as well as fuel. Mathieson's Ljungstrom occupies only about 1000 cubic feet, but cuts boiler exhaust temperature from 680°F to 320°F — puts 360° of heat back to work in the boiler.

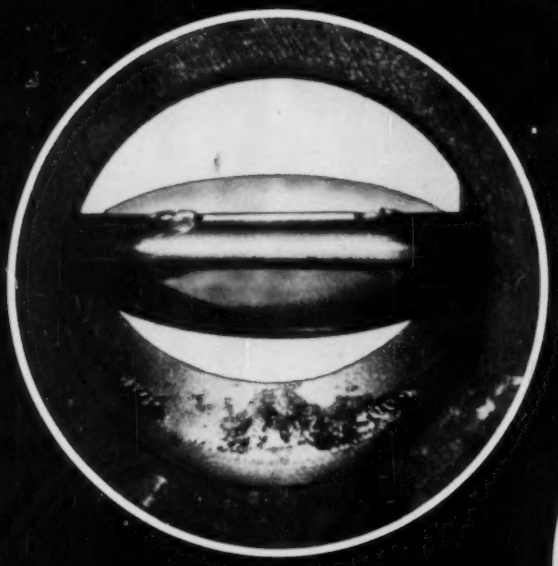
The compact preassembled Package Air Preheater is ready to run when it's delivered—just connect to the power line and ducts, and it's on-stream. You make big savings on installation because there's no on-the-spot erection.

You can use a Ljungstrom Package Air Preheater on boilers from 25,000 to 250,000 pounds of steam per hour. For more information, write today for your free copy of a 14-page booklet.

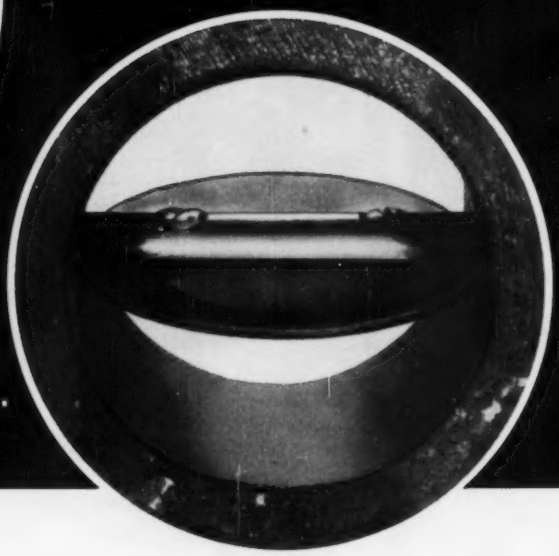
THE AIR PREHEATER CORPORATION

60 East 42nd Street, New York 17, N. Y.

S-41-K



. . . removes
carburetor deposits



keeps
carburetors clean . . .

At a minimum additive package cost S-41-K provides outstanding performance. It cleans-up carburetors in which deposits have formed and keeps them clean. S-41-K has been proven, in actual use, to function without introducing undesirable side effects. You can eliminate, with S-41-K, a common headache for mechanics and motorists alike . . . rough engine idling, frequent stalling and gasoline waste due to dirty carburetors.

For further detailed information write to . . .

Central Soya
Chemurgy Division
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Refractory insulating concrete linings keep cats cracking

Refractory insulating concrete, bonded with LUMNITE calcium-aluminate cement, is being used more and more to line regenerators, cyclones, strippers, catalysts and reactor transfer lines of fluid catalytic cracking units. On stream in FCCs across the country, these industrial concrete linings will resist severe erosion and abrasion caused by catalyst fines ... resist attack by acid condensate ... and provide insulation at high temperatures.

Installation of monolithic concrete linings is fast, easy, economical — whether cast in place, gunited or plastered. Concrete reaches service strength in 24 hours.

For added convenience, castables bonded with LUMNITE cement are available from leading manufacturers of refractories. These are packaged mixtures, ready for use with just the addition of water. For more information, write Universal Atlas Cement, 100 Park Avenue, New York 17, N. Y.

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SKINNER-SEAL
PIPE JOINT CLAMP STOPS LEAKS
at joint where pipe is screwed into fitting

SKINNER-SEAL
PIPE JOINT CLAMP stops leaks at joints where pipe is screwed into fitting. Any temperature—any pressure up to 2,000 pounds. Saves the cost of tearing out and renewing leaky fittings. Prevents shutdowns. In stock at most oil supply stores.

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EMERGENCY PIPE CLAMPS for safe, sure, lasting repair of splits and rust holes in pipe. No pressure too high. Anyone can apply in a few moments. Made in all sizes, ½" to 12", for steel and C.I. pipe. Stocked by practically all oil supply stores.

Complete line of Repair Clamps. Send for Catalog 54!

M. B. SKINNER CO.
SOUTH BEND 21, INDIANA

The Mail Box...

Re Process Secrecy

To The Editor:

You are to be commended on a splendid piece "Process Secrecy—Wise or Otherwise?"

I should like to point out that chemical companies are just as reticent in sharing most of their fundamental data such as reaction and physical process kinetics even for old processes for which they need have no fear of economic loss. Their argument has been the same—economics. I hold that they certainly have improved their process know-how to such an extent that the initial plant design would be uneconomical. Further many designs can be made based on the same fundamental reaction and physical process kinetics, and this information should not be held in the secret category.

I am certain that engineering graduates would benefit enormously by dealing with real rather than estimated or assumed kinetic information. These benefits, of course, would go to the industries which retain them.

My views in this connection were presented in a letter to the editor in Chemical Engineering Progress, March 1960 pp 27-28 and only one positive reply was received on the proposal—from a chap who was fighting to get a release on fundamental information from his own company to include in a book published by his company.

I should be interested in learning of the reaction you get from your readers, particularly the executives who pride themselves in hiring scientific sleuths to analyze his competitor's processes and products while believing that his competitor is making no such effort.

George W. Preckshot
Associate Professor
Dept. of Chemical Engineering
University of Minnesota
Minneapolis

Wilt Read Paper

To The Editor:

When you reported our API paper (May 1961, page 163, "Chromatography Pays Its Way on Alky"), you showed me as being the speaker. Although I had been scheduled to give the paper, a last-minute illness made it necessary for Ray L. Wilt to make the presentation.

Mr. Wilt certainly deserves full credit for the presentation. Also please make sure the spelling of his name is correct, rather than "Witt" as it appeared on page 163.

John H. Williams, Jr.
Media, Pa.

New Filing System

To The Editor:

We are anxious to start a new filing system based on the one outlined in your May 1961 edition ("New Information Retrieval Standards"), and would therefore be grateful if you would send us a copy of the Thesaurus as soon as it is available.

John McGarry
Signal Oil and Gas Company
Los Angeles.

Editor's Reply: *The "Chemical Engineering Thesaurus" may be obtained from the American Institute of Chemical Engineers, 25 West 45th Street, New York 36, N. Y. Copies are $5. for A. I. Ch. E. members, $10. for non-members.*

Supplements Work

To The Editor:

Unfortunately, the author of "Analyze Plant Control by Transient Response" (R. J. Fanning, PETROLEUM REFINER March 1961) gave only the transient response curve of the broken control loop. It might be useful to see the influence of the different controller settings on the closed loop. You could have seen then that Ziegler & Nichols formulas will not give the best solution.

We prefer to apply formulas as pointed out in the "Regelungstechnik" December '54/January and February '55. There you can find an article "Uber die Vorausberechnung Optimal Abgestimmter Regelkreise" (Precalculation of Control Loops with Optimum Design).

The article's author pointed out that this optimum design will exist with only one over-oscillation of approximately 4 percent. He then found that the ascent to the new value will last approximately 5 times the sum of the small-time lags in the loop.

To reach this result he used some simple formulas which I feel are applicable. Since the described reaction curve is the result of 2 lag times, you have to use a three-mode controller. That fits the results of Dr. Fanning. Furthermore, you can find in the abovementioned article that the controller settings must be adequate for the lag times found from the reaction curve. That means: the controller

A NEW ADDITION TO THE SONAC *LINE*

POSITIVE ULTRASONIC LEVEL CONTROL

The components of Sonac (sensor actual Size)

Now, two new ultrasonic sensors, especially for level control have been added to the Delavan line of SONAC sensing and switching devices.

The single sensor system is recommended for liquid level control and the double sensor system for dry level control.

Control is maintained by installing the SONAC sensor through the wall of the vat, bin or hopper. When the oscillation on the face of the sensor is dampened or impeded by the material being sensed, the signal to the control unit changes, activating a relay.

FIG. 1—LIQUID LEVEL (One Sensor)

FIG. 2—DRY LEVEL (Two Sensors)

For level control, SONAC is accurate to .005″ and has a response time of 25 milliseconds. Performance of the sensor does not deteriorate with age.

The level control uses to which SONAC can be applied are virtually unlimited. It is not affected by the viscosity*, specific gravity, conductivity, or capacitance of the material being sensed. Temperature or pressure changes of the material do not alter its performance. False signals are eliminated because SONAC may be adjusted so as not to sense steam, foam, or vapors.

*Viscosity may affect response time.

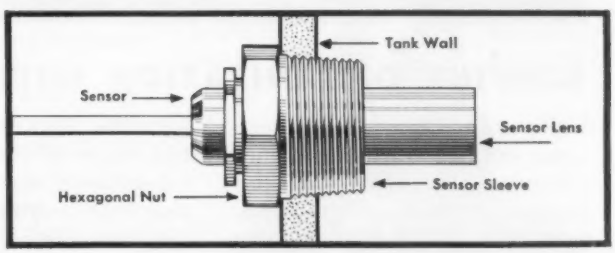
Canadian Representative:

KNOWLES & FOSTER (North America) Ltd.

708 Terminal Bldg., Toronto 1, Ontario, Canada

SONAC is extremely rugged. Sensors are type 304 stainless steel. The electronic components in the sensors are hermetically sealed and will withstand pressures to 2000 psi and temperatures from −425° F. to +450° F. They are immune to shock, vibration or mechanical damage.

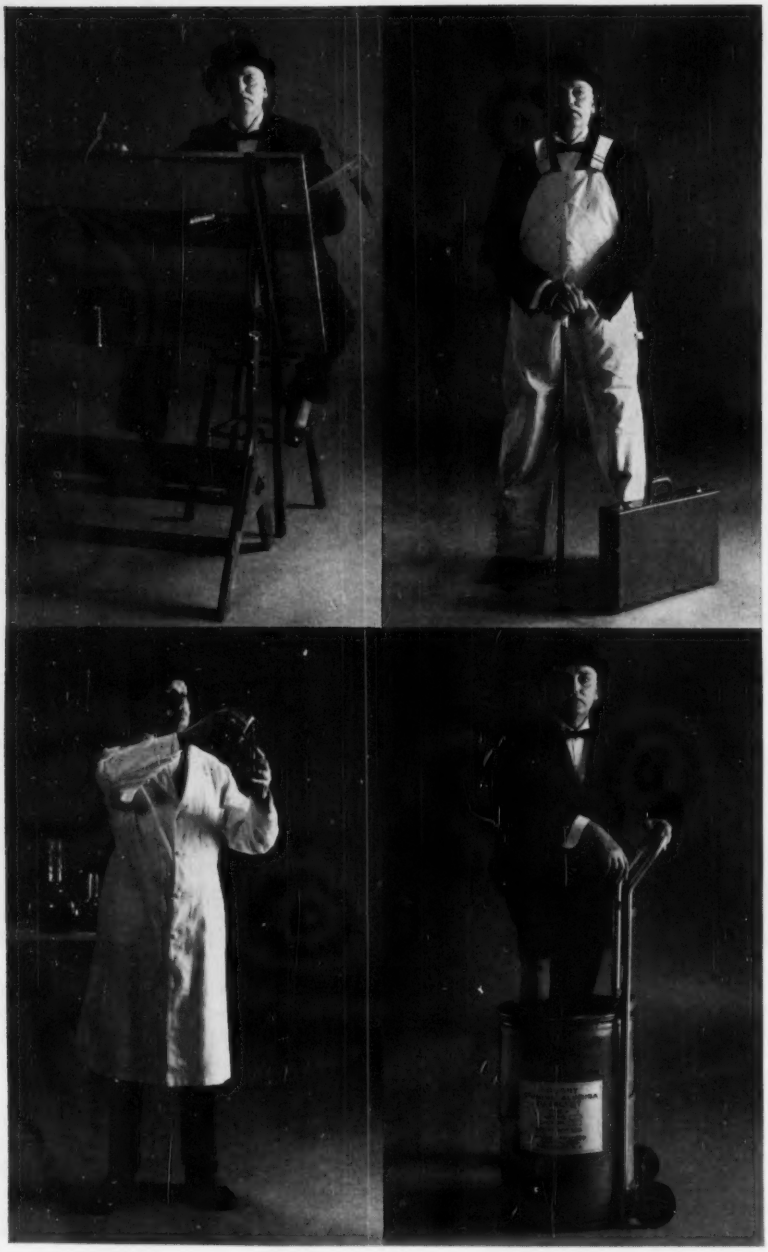
The control is a compact unit 5″ x 5″ x 5″ and features transistor circuitry. Power consumption is one watt and the unit will operate in temperature ranges from 40° F. to 135° F.



The compact single SONAC sensor usually is inserted through the tank wall, as indicated in the above drawing. It can be arranged in other ways, too.

There are dozens of applications for SONAC *single and double sensor units. Let it go to work for you now, write:*

DELAVAN
Manufacturing Company
WEST DES MOINES • IOWA



SERVICE ORGANIZATION WITH SCOPE

Unlike other service organizations, HOUDRY offers experience not so much in solving particular types or categories of problems, as in dealing with the full range of catalytic processing.

More specifically, HOUDRY offers thorough knowledge of the entire field, as well as its specialized segments. As a result, the potential value to you of individual categories of service . . . contract research . . . engineering and technical assistance . . . process design . . . economic consultation . . . and chemical and catalyst services . . . is strengthened by ready access to so much useful collateral experience.

*HOUDRY
PROCESS CORPORATION
1528 Walnut Street, Philadelphia 2, Pa.
*Houdry means Progress . . . through Catalysis

The Mail Box . . .

settings ought to be 5 reps/min and 0.08 minutes (for rate). The figures for reset was verified by Dr. Fanning, too, and I am sure he could have gotten better control by setting rate on 0.08 minutes.

Since the amplification of the broken control loop was not given, a calculation of the PB could not be made. It might be interesting to carry out the calculations of Dr. Fanning in the mentioned manner. Seldom does a control engineer have the opportunity to check process response calculations! Thus we owe thanks to Dr. Fanning for his investigations which I would only supplement.

Rolf Morgenstern
Frankfurt (Main)
Germany

AUTHOR'S REPLY

Yes, Mr. Morgenstern's letter points out methods by which my work can be supplemented and improved.

Dr. R. J. Fanning.

"Good Work"

To The Editor:

In your May issue, we note your editorial "We Must Keep Our Patent System!" We found it very interesting and timely. Keep up the good work.

We are enclosing a memo dated 24 April 1961 on the subject of Patents, Copyrights, and Proprietary Equipment, along with other material on the same subject. We hope you will find it interesting; please feel free to use it in any way you may desire.

Hugh C. Robbins,
President, Robbins Aviation, Inc.
Los Angeles

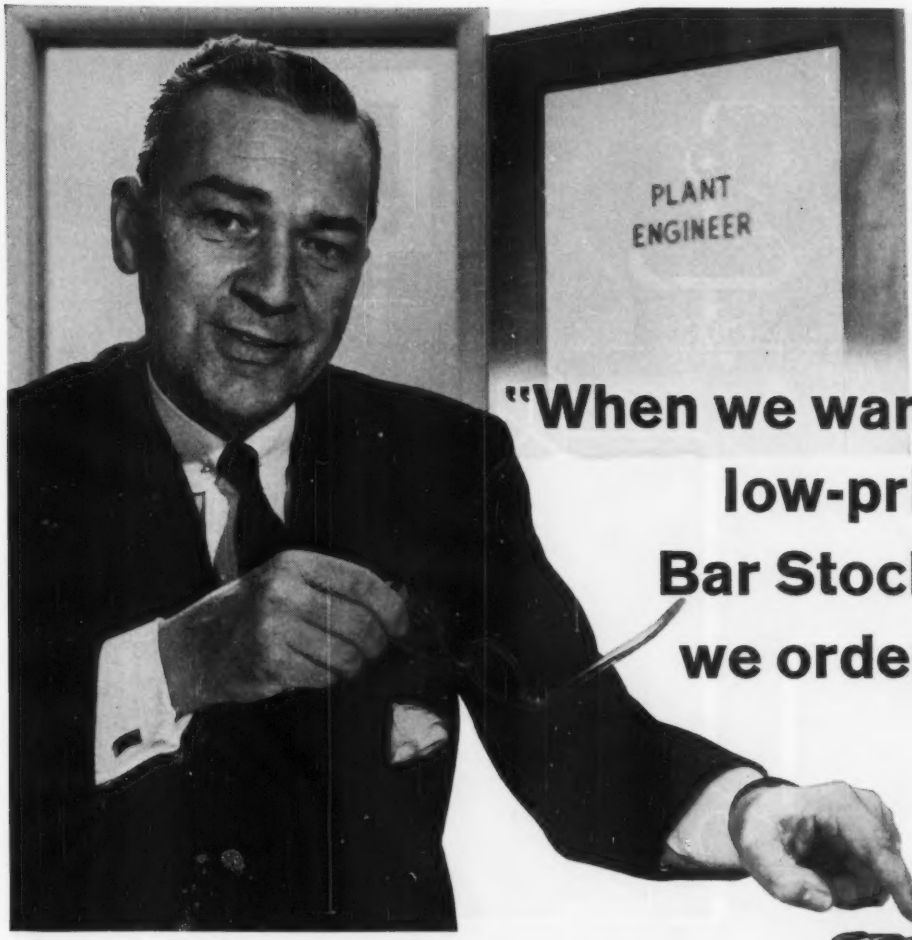
Correction

The definition of "m" under equation (7), Part 2, of my article on "Use Fractions for Recycle Balance" (HP-PR, June, pp. 189-192) should read "The total number of all possible non-overlapping *pairs* of recycle loops."

M. A. Vela
Monsanto Chemical Company
St. Louis

The Editors invite reader comment on topics of timely interest to the hydrocarbon processing industry.

Address Box 2608, Houston 1, Texas.



"When we want rugged, low-priced Bar Stock Valves we order R-P&C"

"For a really versatile, **all-purpose** valve, we've found there's none better than R-P&C bar stock valves. Designed and built **for close control service,** the construction of these valves makes them well suited to many general purpose applications as well. For example, the **compactness** of R-P&C bar stock valves is particularly advantageous for close-coupled installations in instrument lines or on panel boards and for pressures up to 10,000 lbs. in steel."

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We highly recommend R-P&C bar stock valves for meter, gauge, sampling, or test valves on equipment requiring a reliable compact valve that can withstand high pressure service.

Contact your R-P&C distributor for full details about bar stock valves in bronze, carbon and stainless steels plus the complete line of R-P&C gate, globe and angle valves in all standard materials.

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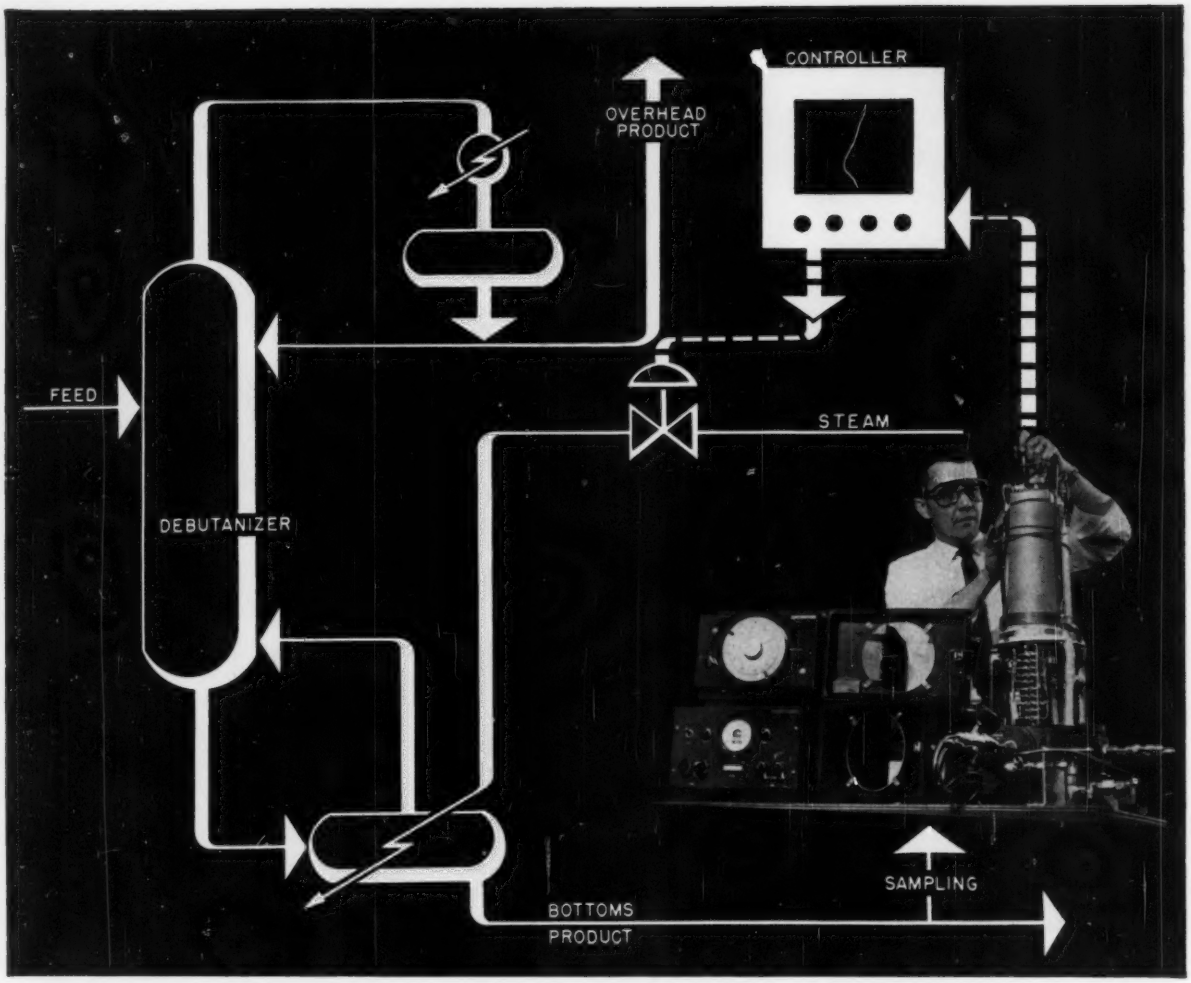

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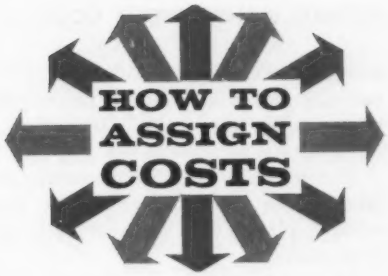


How to Estimate Plant General Costs

Oliver Axtell, Celanese Chemical Co.
New York City

R. M. Pritchett, Celanese Corporation of America,
Clarkwood, Texas

The plant general expenses of operating a petrochemical plant are the overhead costs. Thus costs incurred in purchasing, accounting, engineering and traffic activities are typical plant general expenses. Here's how total plant general expenses can be estimated when the economics of a proposed new petrochemical plant are being evaluated.

What Plant General Costs Include. First consider the plant general expenses for an entire plant, which usually contains several separate processing units and a utilities area. The plant general expenses of such a plant are primarily those required to keep in operation the Accounting, Personnel, Mechanical Engineering, Process Engineering, Production Control, Purchasing and Traffic departments.

Specifically, plant general expenses can be collected in plant accounts such as those indicated in Table 1. Examination of these items shows that they are shared among all the processing units, along with the maintenance and utilities areas. Plant general expenses thus are not so logically charged to the individual units on a usage basis as are the other plant expenses.

What Plant General Expenses Exclude. Interest charges are excluded since they are not considered to be a part of plant cost. Likewise, corporation overheads are excluded. These are the expenses for sales, research, corporate office staff and management personnel above the level of plant manager.

The following plant costs are excluded from plant general—

1. Raw Materials
2. Direct Operating Labor
3. Maintenance
4. Depreciation
5. Control Laboratory

Estimation of Plant General Expenses. In preliminary economic evaluations, the total plant general expense, for a proposed plant operating at full design capacity, can be estimated as a percentage of the sum of the annual cost of labor, maintenance and utilities.

In this definition, labor includes operating labor, packing labor, shift supervision, and over-all supervision. Over-all supervision is defined as that up to the level of area superintendent. Thus the salaries of the plant production superintendent and his staff are plant general expenses, as are also the plant manager and his staff. The salaries of the production unit superintendents are part of the labor costs of the units.

Utilities are charged to the process units at production cost, including depreciation, in the utilities area.

On the foregoing basis, the plant general percentage lies between 25 and 55 percent, with the higher figure applying to small plants. Most of the data range between 30 and 45 percent.

As a specific example, it is desired to estimate the total annual plant general expense for a proposed new petrochemical plant. The cost of labor is \$200 M/yr when the plant is operating at full design capacity. The cost of maintenance is estimated to be \$150 M/yr, and the cost of utilities, \$300 M/yr. The total plant general expense would be estimated as a percentage of the sum,

TABLE 1—PLANT GENERAL EXPENSES

Administrative	Automobiles and Trucks	Police and/or Watchmen
Industrial Engineering	Standards-Time Study	Library
Main Office	Stenographic	Production Control
Personnel Building	Communications	Packaging Development
General Accounting	Personnel	Grounds and Roadways
Cost Accounting	Training School-Employees	Yard Lines
Statistical Department	Suggestion System	Railroad Sidings
Tabulating Department	Foreman Training Program	Incinerator
Payroll	Quality Control	Disposal System
Printing and Duplicating	Safety	River Pollution Control
Receptionist and Switchboard	First Aid	Process Engineering
Telephone, Telegraph and Teletype	Fire Department	Cafeteria
Billing	Group Insurance and Retirement Plan	Company Homes
Purchasing	Stores-General	Employee Recreation
Traffic	Stationery Stores	State and Local Taxes
Timekeeping-Checkers	Salvage Department	

which in this case is $650 M/yr. Using a factor of 45 percent, the total annual plant general expense expected when the plant is operating at full design capacity would be $290 M/yr.

The selection of the appropriate percentage factor is based upon a comparison of the proposed plant with existing plants, with the size of the plant a major consideration.

In final economic evaluations, such as those upon which a new, large major expenditure is to be justified, a detailed estimate of the expected plant general expenses is made.

Alternate Approaches for Preliminary Evaluations. The technique of using a percentage of labor, utilities and maintenance costs is entirely empirical, though based on actual experience with operating plants. Certainly one improved approach would be to compute the plant general expense as the sum of x percent of labor, y percent of maintenance and z percent of utilities. So far, however, this has not been explored, nor has the relationship between the capital investment and the annual plant general expenses.

Still better might be an approach in which the salaries in the Accounting, Personnel, Mechanical Engineering and other plant general departments are computed and then multiplied by a factor to secure the total cost per year of operating these departments. This is logical because salaries represent the majority of the annual plant general expenses. A computer program could be developed whereby the input data would include the number of people in each of the plant general departments. Further, the number of people could be correlated with the size of the plant.

Startup. During the early months of operation of a new plant, plant general expenses may be unusually high, including such costs as relocation and operator training. These have to be estimated individually for each case.

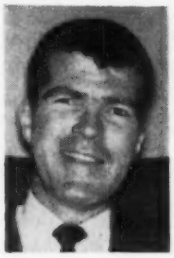
Fixed and Variable Components of Plant General Expenses. An examination of the plant general cost accounts in Table 1 shows that for a continuously operating petrochemical plant these are almost entirely fixed charges. One reason for this is the previously mentioned high proportion of salaries in these expenses. Another is the inclusion, by definition, of insurance, as well as state and local taxes.

Allocation of Plant General Expenses. The prior discussion was initially stated to consider the estimation of plant general expenses for the entire plant. At times, however, one may wish to allocate total plant general expenses among the various production units. If this is done, each unit can be viewed as an individual block, and thus certain blocks can be readily removed from, or placed in, the proposed plant. It is convenient to use the same plant general percentage factor, based on labor, utilities and maintenance costs, for the individual blocks or units as is used for the entire plant.

Incremental Plant General. The problem of estimating plant general expenses is truly greatest in the case when a small addition is made to a large existing plant. As a specific example, suppose that an additional reboiler is to be installed to debottleneck an existing fractionation column. Very little actual change in plant expense would be expected for this particular addition. Yet the sum of many such individual changes about the plant will in truth eventually increase the total annual plant general expense of the plant. The writers prefer not to adhere to a hard and fast rule in these situations. Most often the conservative approach is taken, in that an addition to existing facilities is charged with increased plant general expense by applying the standard percentage factor for the entire plant to the increase in labor, utilities and maintenance. In cases involving large expenditures, a detailed estimate of the increase in plant general expenses is made.

Need For Further Investigation. The effects on plant general expense of the number of products produced in a given plant, and whether the processing is batch or continuous, need to be studied. Comparison of plant general expenses in petrochemical plants with those in plants of other industries would also be of interest.

About the Authors



Axtell

Pritchett

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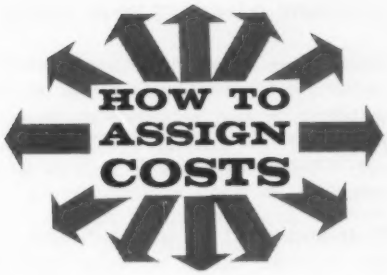
Key words for indexing

Burden
Costs
Distribution
Economics
Expenses

(See PETROLEUM REFINER, Vol. 40, No. 5, May 1961 p263)



How to Distribute Manufacturing Costs

Determine, assign and distribute indirect and direct manufacturing costs for maximum profit with adequate investment return

Allyn B. Meyers, National Aniline Division
Allied Chemical Corp., New York City

A plant manager is charged by his executive management with the responsibility for manufacture of saleable products at minimum costs. His goal is to achieve maximum profits and adequate return on investment. This covers a large order for any manager in today's competitive and complicated business world. Knowledge and understanding of factory costs coupled with firm and realistic control measures, can ease his difficult task of accountability to top management. What is the make-up of these costs? How are they assigned to manufacturing departments, and who in the organization is specifically responsible for their control?

Scope. This article will discuss a moderate size chemical plant equipped to make a variety of mostly bulk products for several different industries. The operations are characterized by both batch and continuous processes. About 350 people are employed at the site.

Standards. A standard cost system reflecting attainable costs under conditions expected for the current year, is used. Normal standards, rather than ideal or best possible standards, are used because our management believes that evaluations based on such norms are fair, realistic and conducive to full support from all levels of supervision.

Standard product costs are intended to be used for one year, unless significant changes due to important process modifications, introduction of new facilities, or major price changes warrants revision. Of great importance to the success of this program, is the close working relationship between Accounting and those supervisors who are responsible for various elements of cost. These supervisors are the people who set standards for their own areas of activity, while the Accounting Department provides necessary historical data, review and advice, and the framework for converting operating data to product costs.

PRODUCTIVE MATERIALS

Generally, in the chemical industry, the largest single element of cost is raw and productive materials. These may be defined as purchased materials which, after further processing, become the components of one or more of the company's manufactured products. Productive materials are variable costs in that their usage varies or should vary directly with the operating level of the consuming or end products. They are controllable costs in that usage can be controlled by the production supervisor, foremen and workers who perform the processing operations. How, then, are standards established for productive materials and, where more than one consuming department and end product are involved, how do we properly account for total consumption?

Yields. First of all, during the development stages of a new product or the process modification of an existing product, a chemist or engineer, through laboratory study, pilot plant demonstration, and eventual full

scale manufacture, develops a yield relationship between productive materials and final product. This is usually expressed in simple quantitative terms such as pounds of raw material per 1,000 pounds of final product. This is a standard used to appraise actual performance.

Distribution. The main difficulty in accounting for raw material usage is where multiple processes and products are involved. Bulk liquid materials stored in a series of tanks known as a tank farm, often provide for the requirements of several processes. Here the need for suitable metering or measuring devices becomes apparent if any accurate appraisal of yield performance is to be made against standards. If these devices are properly installed and maintained, there is very little difficulty in accounting for use of productive materials at the end of the month, but malfunctions do sometimes occur and this seriously weakens sound process evaluation. When this happens, the accountant must rely on the best judgment of production supervisors to reconstruct actual conditions.

PROCESS LABOR

Process labor consists of the wages of workers directly engaged in manufacturing operations or functions related to such operations, such as routine equipment cleaning and catalyst changes. Included also are salaries of department supervisors and foremen, general factory operating supervisors and the fringe costs of payroll taxes and insurance.

Direct labor is a variable cost, although it may not always fluctuate directly with volume of production. There is usually a plateau arrangement where the factory is manned for either five or seven day operation or for one, two or three shift coverage, depending on production schedules. Direct labor requirements will obviously vary for each of these plateaus. Once a production supervisor has established his standard labor requirements to meet a given schedule, there may be no significant changes in labor to compensate for changes in rate of production during the time period established in the standard.

Direct labor is readily assignable to specific departments and to individual products or product groups within departments. Through the use of daily time sheets, foremen furnish labor distribution to product wherever possible. Where product group distribution is involved, cost of labor is assigned to items within the group on the basis of pounds of production.

Departmental supervision, including foremen, is charged to specific departments and very often direct to products where there are only one or two items. Otherwise, this supervision is distributed to products on the basis of direct labor dollars.

General factory operating supervision, such as the Production Superintendent, is distributed to departments and products based on the total of direct labor and departmental supervision.

Payroll taxes and insurance are recorded as part of the cost of labor and are assigned on the basis of total direct and indirect labor.

The production supervisor and his line foremen are responsible for control and efficient scheduling of direct labor application. For a continuous process where labor requirements are largely fixed by time and adequate coverage, insuring attentiveness to proper process control is the main goal of the foreman. For batch processes and such auxiliary operations as product packout, close control of output must be maintained if standards are to be met.

OPERATING SUPPLIES

Operating supplies includes the value of materials and purchased services used in connection with manufacturing operations. Some of the more important items are filter media, heat transfer media, safety and welfare supplies, charts and miscellaneous small tools.

Cost of supplies is considered a variable expense since the use pattern generally follows volume of production, or cost of labor, or both. The more important and higher cost items are quite readily assignable to specific departments and sometimes direct to product. Where the latter is not practical, the cost is spread on the basis of pounds of production.

Here again the production supervisor takes an active part in setting standards. Unlike standards for raw materials, where he can look at process yields, and direct labor, where he can deal in man hour requirements, the supervisor must begin to think in terms of budgeted expenditures. By reviewing historical cost data, particularly as related to principal items, he can usually established a reasonable budget for a given level of production. The control of supply costs should be a prime target for line supervision since this is an area where significant savings have been and will continue to be made.

FUEL AND POWER

A number of our operations require some form of direct process fuel, such as natural gas or fuel oil. These are purchased commodities and their use is related primarily to the volume of production and in some cases to weather conditions.

Process fuel is always a direct charge to consuming products, as determined by suitable metering devices, and is distributed on production volume. Standard usage is determined by the production supervisor of each department on the basis of past experience, tempered by known abnormalities and changes in volume.

Power services are represented by both purchased items and items generated in our own power plant. Electricity, obtained from the local utility, is metered to the major production cost centers or buildings, but not to various processes operated in these buildings.

Steam is generated in the plant boiler house. This is a separate cost center to which all costs related to steam generation are charged to arrive at a cost per net ton produced. Steam consumption in production centers is metered, but as in the case of electricity, we have the problem of assignment to individual products. At this point we have a choice of methods. If only one product is involved, the answer is obvious. If several products are made, and batch sizes and operating

cycles are similar, assignment is made on volume of production. Where this is not the case, theoretical power consumption factors are calculated and distribution is made accordingly.

Power requirements of production departments are treated as variable expenses related to plant activity and weather conditions, although some portion of this expense, such as heat and light, is fixed. Power consumption by service areas, like laboratories, shops and offices, is a fixed expense. This general expense is assigned to production departments and product costs, based on direct consumption. This is an arbitrary method of allocation which is condoned because indirect power is relatively small.

Standard power consumption is determined by each production supervisor by review of processes to be operated, anticipated production volume and past experience. The indirect portion is included for purposes of calculating product standard costs.

MAINTENANCE

Like most companies, we have two basic goals in accounting for maintenance activity. The first is development of cost data related to maintaining a specific machine or group of items comprising an operating unit. Such data are absolutely essential to our plant engineers in evaluating the economics of repair or replacement. The second goal is equitable assignment of maintenance costs to departments and products.

Job Orders. The first objective is accomplished through the job order system. Requests for maintenance service are initiated by preparation of work requests, which after approval by department supervisors, are forwarded to the maintenance department for cost estimate and scheduling of work. Each month Accounting provides a report of job order expenditures to provide a check on actual cost compared to estimate, and to accumulate historical data for economic evaluation.

Repair Costs. Turning to the second goal, we are interested in accurate repair costs chargeable to various departments and products and also some indication as to the nature of repair service provided. Maintenance activity is first broadly classified as to whether it is bona fide repair work, servicing, or mechanical work of an expense nature. Through a series of account numbers, costs in each of these three categories are identified as pertaining to process equipment, buildings, laboratories, power facilities and others. The next step covers actual cost distribution.

Distribution. Repair and servicing costs are assigned direct to departments and to products wherever possible. For multiple product units, distribution is based on volume of production. Mechanical work in the third category comprises minor additions which are not capitalized, equipment relocations, and tools and supplies used by maintenance personnel. Much of this work may be charged direct, while the general or indirect portion is distributed on the basis of capital investment. Finally, supervision and payroll fringe costs are assigned on the direct labor pattern.

Service Departments. Maintenance costs are charged to service departments in the same manner as production departments, using distinguishing cost center numbers. These are subsequently assigned to production based on service rendered, such as steam consumption, use of electricity, refrigeration service, etc. Maintenance costs associated with offices, shops and other general service areas, are spread on capital investment.

Predicting maintenance expenditures for purposes of establishing budgets and setting standards, is a joint effort of maintenance supervision and the various departments requiring service. Naturally, the more comprehensive the background data, the more accurate and reliable the prediction becomes. The maintenance supervisor acquaints himself with the operating schedules established for the coming year to meet sales demands. The size of the repair organization and the number of trades is determined based on past experience, tempered with some knowledge of what major or periodic overhauls may be expected. After repair and service labor costs have been estimated, material usage is predicted as a percentage of labor. This is a reasonable approach in setting standards for one year since detailed bills of materials for even all known jobs are not prepared until shortly before scheduling of field work. In the case of new facilities, maintenance costs are estimated as a percentage of capital investment for the plant as a whole or for any similar facilities, if they exist.

LABORATORIES AND TESTING

Testing operations are performed at several stages in the manufacturing cycle of a sales product, starting with analysis of purchased raw materials, intermediate work in process steps, and finally the finished product. These are generally considered to be variable costs related to production volume and consequently need for service. Once volume has been determined, testing labor requirements and materials and supplies are predicted, considering past experience.

Test Records. During the month a record is kept of the number of tests performed on all products, including raw materials. Knowing the normal time required for performance of each type of test, it is possible to develop a distribution pattern for assignment of actual monthly charges to finished production.

WAREHOUSING AND TRANSPORTATION

In this discussion, warehousing refers to functions carried on at the plant location, and transportation and material handling operations concerned with movement of materials within and around the plant. The warehousing account is divided into four sections and costs are accumulated for each. These are warehousing for raw materials, packages and containers, finished products, and mechanical and factory supplies. Assignment to production departments is a direct charge in many cases.

Raw Materials. Only departments and products using purchased raw materials receive a charge for this serv-

ice, based on production volume where multiple products are involved.

Containers. Costs related to handling and storing containers are distributed only to products packaged for sales, since many of our products are bulk liquids sold in tank cars or trucks.

Finished product warehousing consists of handling and storing sales items and includes such operations as movement in and out of the warehouse, labelling, palletizing and loading products to trucks for shipment. These costs are assigned to sales products only and not to intermediate products stored in production departments prior to further processing

Mechanical Supplies Storeroom. Since most of the materials in the storeroom are disbursed to the field repair forces, cost assignment to departments and products is made on the basis of maintenance costs.

Transportation costs are for the most part general in nature and must therefore be distributed on as equitable a basis as possible. Included among these costs are operation of plant vehicles, wages of drivers, railroad switching charges and demurrage. There are a few instances where work is clearly related to the movement of a bulk item and in such cases, costs are charged direct to product. General costs are assigned on either a process labor or production volume basis, whichever seems more appropriate for concerned departments.

Development of annual budgets and standards for warehousing and transportation is accomplished in much the same way as other factory costs. The expected production schedule for the coming year is the best guide in estimating the variable costs of handling raw materials and finished goods, while operation of the storeroom and plant vehicles are considered to be fixed costs.

FIXED COSTS

The major portions of the cost elements discussed to this point are variable in nature and for the most part controllable by either production supervisors and foremen or by heads of the respective service departments. The fixed portions of these costs represent the supervision and services which management considers essential to sustain and insure the smooth operation of all departments, regardless of the particular year's production level.

Fixed costs can be broken into two large groups.

First—general factory administration costs, including salaries of plant management personnel, accounting, purchasing, traffic and other staff functions, as well as telephone and telegraph expense, medical service, stationery, postage and similar charges. These costs are fixed by management planning for a relatively long period of time as being necessary for efficient administration of the plant. These organizational costs are not subject to control or variation due to monthly production volume changes, nor even annual volume changes, unless major facilities are added to the site or shut down or removed. Administration costs bear little or no relation to specific departments and therefore some arbitrary method of assignment must be adopted for purpose of developing product costs. In our opinion, distribution to products on the basis of process labor is equitable for our operation.

Second—depreciation, insurance and taxes related to plant investment. The amounts of these costs are noncontrollable, having been incurred by management decisions made in the past to provide capacity for visualized future sales needs. These capacity costs differ from plant administration in that they are readily assignable to specific departments and product groups. Application to cost centers and products is made on capital investment. Charges for general plant areas, such as offices, shops and roadways are assigned on the basis of previously distributed direct charges.

SUMMARY

It is obvious that good cost control can be attained only by the concerted efforts of all levels of supervision starting with the manager and extending to line foremen. Each individual can, of course, exercise control over only those items within his sphere of responsibility. It is essential that he participate in establishing standards for material consumption, budgets for labor, and other manufacturing expenses in order that his performance may be judged in the light of attainable standards. At the same time, these individuals should be interested in complete product costs and the over all results of their operation, through the reasonable application of general and fixed costs to their areas.

About the Author

Meyers

Allyn B. Meyers is supervisor—costs and inventory for the National Aniline Division of Allied Chemical Corporation in New York. He is responsible for cost accounting activities of several plant locations in the General Office. In addition to correlating data supplied by plant comptrollers, Mr. Meyers prepares special cost studies and reports for management. Mr. Meyers has been with National Aniline since 1941 in various accounting and administrative positions. He received a B.S. in Business Administration from the University of Buffalo.

Key Words for Indexing

Accounting	Fixed	Raw Materials
Burden	Fuels	Steam
Control	Indirect	Supplies
Costs	Labor	Testing
Distribution	Maintenance	Variable
Economics	Power	

(See PETROLEUM REFINER, Vol. 40, No. 5, May 1961 p263)

HOW TO ASSIGN COSTS

Estimate Forced-Draft Fan Costs

These data permit rapid budget estimating of heavy duty forced-draft fans complete with turbine drives and gear reducers over a range of 30,000 to 150,000 scfm

N. H. Prater, Mobay Chemical Co., Pittsburgh, Pa.

D. W. Antonacci, The Chemstrand Corp., Pensacola, Fla.*

FANS WITH CAPACITIES of 30,000-150,000 scfm and pressure ranges of 10 to 20 inches of water are covered in this article. These fans are commonly used on forced-draft boilers and other heavy-duty applications.

Sizes above this range should be rated individually by the fan manufacturer involved while sizes under this range would normally be included as part of the boiler plant or power station.

Estimating reasonable budget prices for heavy-duty mechanical fans can become a long and tedious job. With such a large choice of fans on the market and with one specific fan capable of performing over a wide range of flows and pressures, a presentation of costs to cover fans in general would become a cost article of infinite scope.

Fans. These fans are heavy duty type, with the fan housing fabricated from welded steel plate. The access door and housing is braced to withstand the internal working pressures and a split housing is utilized to allow removal of the fan wheel. The fan wheels are also heavy duty, all welded construction with die formed airfoil contour blades, internally reinforced with the trailing edge vented for expansion. The sleeve bearings are standard self-aligning, external pedestal supported type and include ring oil lubrication with water cooling.

Drivers. Steam turbines and electric motors are used in most installations to drive these heavy-duty fans. It is

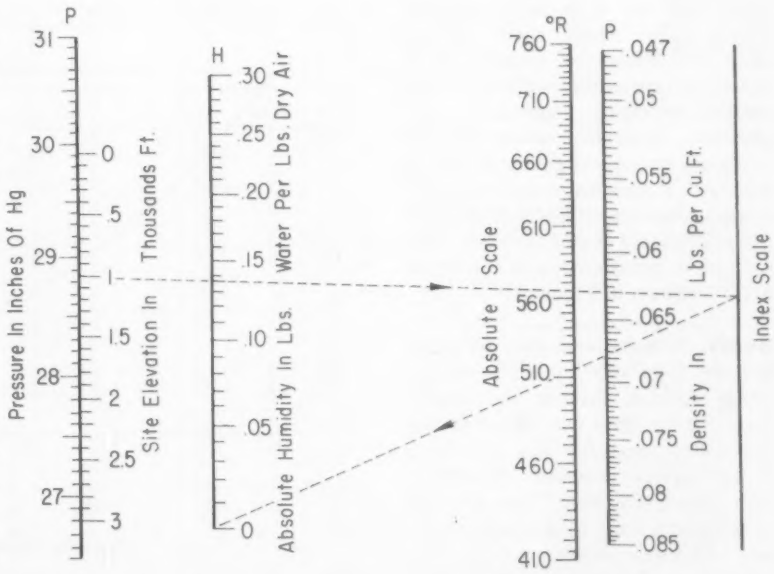


FIGURE 1—Gives density of air at various elevations and temperatures.

* Present address: U.S. Naval Air Station, Pensacola, Fla.

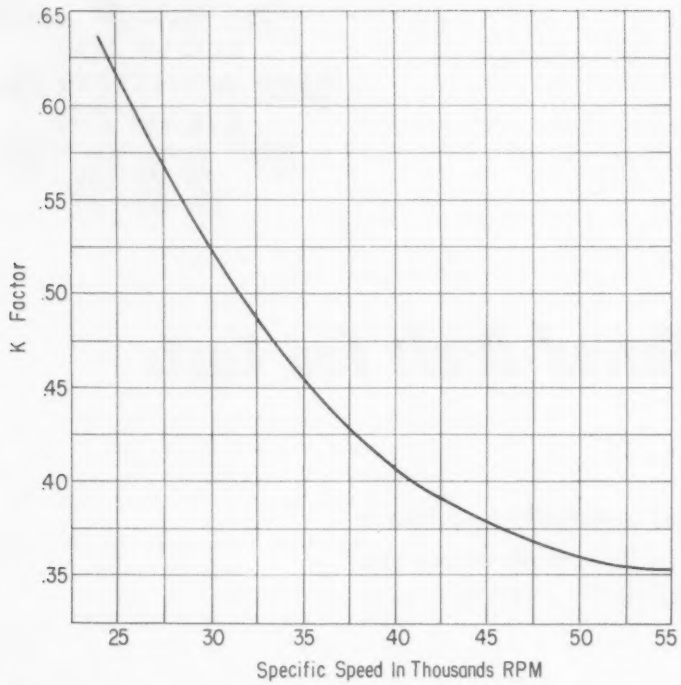


FIGURE 2—Use these fan rating factors for single inlet, single width, airfoil blade mechanical draft fans.

not always possible to decide immediately which driver is best for a given service. However, for estimating purposes, the cost of a suitable steam turbine driver will be included here. These units are single-stage, double-wheel turbines having steam inlet and exhaust connections in the lower half of a horizontally split casing. The steam chest, casing, shaft and blades are constructed of materials compatible with the steam turbine operating temperature and pressure. Standard accessories include an overspeed governor and a mechanical constant speed governor in accordance to NEMA Standards for mechanical steam turbines. The estimated purchased cost of these units is shown in Figure 4.

Gears. A high-speed gear set must be used as a speed reducer on the steam turbine driving the slower speed heavy duty fan. Most of the heavy duty gear sets are connected to the driven machine through a high speed coupling, however, in some cases a built in gear set can be used. The gear sets most often employed are the double helical gear type. The housing is of high quality, close grained, gray cast iron and split horizontally to facilitate ease of inspection. The upper half of the gear housing is fitted with a large opening and cover for routine inspection of gears, pinion and oil supply. The shaft, gears and pinion are constructed from materials suitable for long operating life. The bearings are two piece, sleeve type with spaced oil grooves for even lubrication. The lubrication system is a positive, forced-feed, self-contained system with an external water cooled heat exchanger and standard lubrication accessories. The estimated cost of these heavy duty gear sets can be obtained from Tables 3 and 4.

Fan Sizing. In order to arrive at the appropriate size along with an estimated price for the major components of a heavy duty, forced air fan system, the equations and nomenclature listed below will be utilized. It was found that fan specific speed represented the best criteria for determining wheel size and subsequent fan costs.

$$\text{Fan Specific Speed, } N_s = \frac{N\sqrt{Q}}{(ESP)^{3/4}} \quad (1)$$

$$\text{Fan Wheel Diameter} = \frac{\sqrt{Q} \times K}{(ESP)^{3/4}} \quad (2)$$

Equivalent Static Pressure,

$$ESP = SP \times \frac{0.075}{\rho} \quad (3)$$

$$\text{Fan Horsepower} = \frac{0.000157 \times Q \times TP}{E} \quad (4)$$

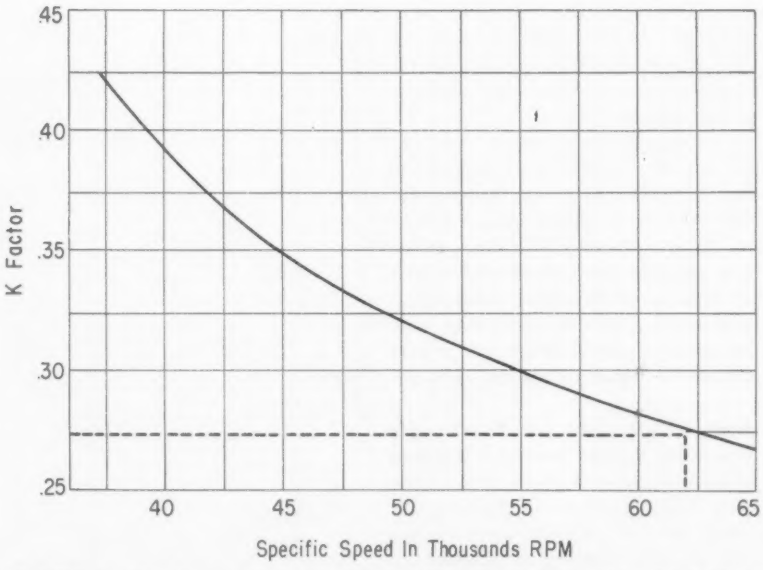


FIGURE 3—Use these rating factors for double inlet, double width, airfoil blade mechanical draft fans.

Did you miss these cost articles?

Estimate Inert Gas Plants Quickly
Feb. 1960, P. 129

How to Estimate Installed Pump Costs
March 1960, P. 161

Steam Turbine Generator Costs
April 1960, P. 185

Here's Packaged Boiler Costs
May 1960, P. 185

Estimating Fractionating Column Costs
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How to Select Demineralization Systems
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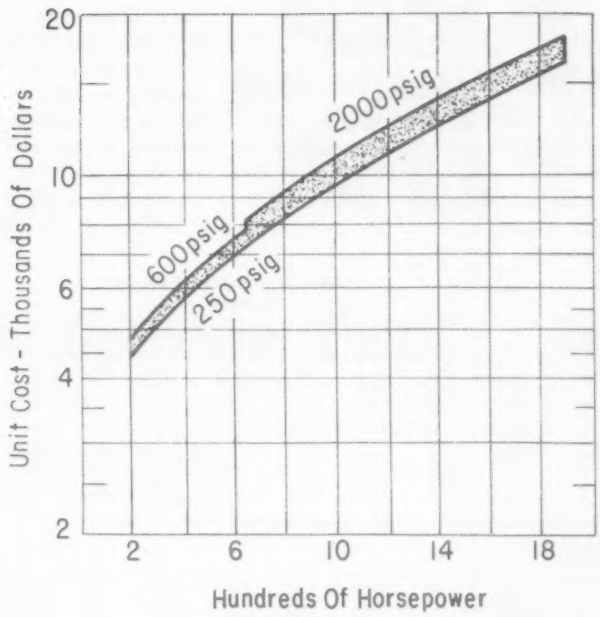

FIGURE 4—These purchased costs are for steam turbines of single stage, double wheel, with steam inlet and exhaust connections in the lower half of a horizontally split casing. The steam chest, casing, shaft and blades are constructed of materials compatible with the steam turbine operating temperature and pressure. Standard accessories include an overspeed governor and a mechanical constant speed governor. Apply the following correction factors for temperature:

Saturation — 49°Superheat	1.10—1.05
50° SH — 99°SH	1.08—1.06
100° SH —200°SH	0.96—0.98
201° SH —300°SH	1.00—1.00
301° SH —349°SH	1.07—1.04

TABLE 1—Cost of Mechanical Draft Fans

	SINGLE WIDTH—SINGLE INLET					DOUBLE WIDTH—DOUBLE INLET				
RPM	1800	1500	1200	1000	900	1800	1500	1200	1000	900
Wheel Diameter	UNIT COST—DOLLARS					UNIT COST—DOLLARS				
40 in.	4500	3050	2160	2160	2160	6600	5400	3430	3430	3430
44 in.	5700	5300	3170	2490	2490	8200	7650	5600	3930	3930
49 in.	6550	6150	4000	2960	2960	9600	9100	7200	7200	7200
54 in.	....	7700	7450	4700	3590	....	11200	10700	8500	5680
60 in.	....	9100	8400	6450	5950	....	13100	12500	11400	10300
66 in.	....	....	11900	10200	8050	....	.....	17000	14700	13900
73 in.	....	....	14200	13700	12200	....	.....	20200	19600	17700

Includes standard couplings. Add 15% for variable inlet vane damper and shut off outlet damper.

TABLE 2—Static Pressure Factors Table

Sp	Sp ¼	Sp ¾	Sp	Sp ¼	Sp ¾	Sp	Sp ¼	Sp ¾	Sp	Sp ¼	Sp ¾
3	1.32	2.28	10	1.78	5.62	17	2.03	8.38	24	2.21	10.8
3.25	1.34	2.43	10.25	1.79	5.73	17.25	2.03	8.45	24.25	2.21	10.9
3.50	1.37	2.56	10.50	1.80	5.83	17.50	2.04	8.56	24.50	2.22	11.0
3.75	1.39	2.70	10.75	1.81	5.90	17.75	2.05	8.65	24.75	2.23	11.1
4	1.42	2.83	11	1.82	6.03	18	2.06	8.75	25	2.24	11.2
4.25	1.44	2.97	11.25	1.83	6.13	18.25	2.06	8.84	25.25	2.24	11.3
4.50	1.46	3.09	11.50	1.84	6.23	18.50	2.07	8.92	25.50	2.25	11.4
4.75	1.48	3.22	11.75	1.85	6.34	18.75	2.08	9.01	25.75	2.25	11.4
5	1.50	3.34	12	1.86	6.45	19	2.09	9.10	26	2.26	11.5
5.25	1.51	3.48	12.25	1.87	6.54	19.25	2.09	9.19	26.25	2.26	11.6
5.50	1.53	3.59	12.50	1.88	6.64	19.50	2.10	9.29	26.50	2.27	11.7
5.75	1.55	3.72	12.75	1.89	6.74	19.75	2.10	9.38	26.75	2.27	11.7
6	1.57	3.84	13	1.90	6.85	20	2.11	9.47	27	2.28	11.8
6.25	1.58	3.95	13.25	1.91	6.95	20.25	2.12	9.55	27.25	2.28	11.9
6.50	1.60	4.07	13.50	1.92	7.04	20.50	2.13	9.63	27.50	2.29	12.0
6.75	1.61	4.18	13.75	1.92	7.13	20.75	2.13	9.68	27.75	2.29	12.1
7	1.63	4.30	14	1.93	7.23	21	2.14	9.80	28	2.30	12.2
7.25	1.64	4.42	14.25	1.94	7.32	21.25	2.14	9.90	28.25	2.30	12.3
7.50	1.66	4.53	14.50	1.95	7.42	21.50	2.15	10.0	28.50	2.31	12.4
7.75	1.67	4.63	14.75	1.96	7.52	21.75	2.15	10.1	28.75	2.31	12.4
8	1.68	4.75	15	1.97	7.62	22	2.16	10.2	29	2.32	12.5
8.25	1.69	4.86	15.25	1.97	7.71	22.25	2.17	10.3	29.25	2.33	12.5
8.50	1.71	4.97	15.50	1.98	7.80	22.50	2.18	10.4	29.50	2.33	12.6
8.75	1.72	5.07	15.75	1.99	7.90	22.75	2.18	10.4	29.75	2.33	12.7
9	1.73	5.20	16	2.00	8.0	23	2.19	10.5	30	2.34	12.8
9.25	1.74	5.30	16.25	2.01	8.09	23.25	2.19	10.6	30.25	2.34	12.9
9.50	1.76	5.41	16.50	2.02	8.18	23.50	2.20	10.7	30.50	2.34	12.9
9.75	1.77	5.50	16.75	2.02	8.28	23.75	2.20	10.7	30.75	2.35	13.0

$$\text{Gear Index} = \frac{HP \times S \times F}{Np} \qquad (5)$$

Where:

N = Synchronous speed in rpm
Q = Volume of air handled in cfm at operating conditions
K = Fan rating factor from Figure 2 or 3
SP = Static pressure in inches at operating conditions
ρ = Air density in pounds per cubic foot at operating conditions
TP = Fan discharge pressure in inches
E = Over-all efficiency (assumed 85 percent in most cases)
HP = Horsepower
S = Gear set service factor from Table 6
F = Ratio speed factor from Table 5
Np = Pinion speed or turbine speed in rpm

$(ESP)^{\frac{3}{4}}$,
$(ESP)^{\frac{1}{4}}$ = Static pressure factors from Table 2.

EXAMPLE

The following example is included to illustrate how this data is used to size and estimate the cost of the principal components in a complete fan system. Estimate the purchased cost of a heavy-duty forced-draft fan to handle 122,500 cfm of air at a static pressure of 20 inches and a temperature of 105° F when operated at a speed of 1,800 rpm and installed at an elevation of 1,000 feet above sea level. A steam turbine operating at a speed 4,000 rpm will be utilized as the driver. Steam will be supplied to the turbine at 650 psig and 750° F total temperature.

TABLE 3—Coupled Gear Sets
(Purchased Cost)

Gear Index	.0	.1	.2	.3	.4	.5	.6	.7	.8	.9
0	....	1735	1815	1900	1980	2065	2145	2230	2310	2395
1	2475	2540	2610	2675	2740	2805	2870	2940	3005	3070
2	3135	3195	3260	3320	3380	3440	3500	3560	3620	3680
3	3740	3795	3850	3910	3960	4015	4070	4125	4180	4235
4	4290	4345	4400	4455	4510	4565	4620	4675	4730	4785
5	4840	4885	4930	4975	5015	5060	5105	5150	5195	5240
6	5280	5325	5370	5415	5455	5500	5545	5590	5635	5680
7	5720	5765	5810	5855	5900	5940	5985	6030	6075	6120
8	6160	6200	6240	6275	6315	6355	6390	6430	6470	6510
9	6545	6585	6625	6660	6700	6740	6775	6815	6855	6900
Gear Index	**0.0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
10	6930	7260	7590	7920	8250	8580	8910	9240	9575	9900
20	10230	10530	10825	11125	11425	11720	12015	12310	12610	12900
30	13200	13485	13775	14060	14350	14630	14920	15200	15490	15775
40	16075	16335	16610	16890	17160	17435	17710	17985	18260	18535
50	18810	19030	19250	19475	19690	19920	20130	20350	20570	20790

NOTE: Add for high speed couplings $225 to $375.

TABLE 4—Built-in Gear Sets
(Purchased Cost)

Gear Index	.0	.1	.2	.3	.4	.5	.6	.7	.8	.9
0	....	1550	1630	1710	1785	1870	1950	2030	2110	2190
1	2210	2325	2380	2440	2500	2560	2615	2675	2730	2795
2	2915	2975	3035	3095	3160	3220	3280	3340	3400	3460
3	3520	3575	3630	3685	3740	3800	3850	3905	3960	4015
4	4070	4115	4160	4200	4245	4290	4335	4380	4425	4470
5	4510	4565	4620	4675	4730	4785	4840	4895	4950	5010

NOTE: No high speed couplings required.

TABLE 5—Ratio Factor (F)
(Driver RPM/Driven RFM)

Ratio	.1	.1	.2	.3	.4	.5	.6	.7	.8	.9
2	9	9.6	10.2	10.9	11.6	12.3	13.0	13.7	14.4	15.2
3	16	16.8	17.6	18.5	19.4	20.3	21.2	22.1	23	24
4	25	26	27	28.1	29.2	30.3	31.4	32.5	33.6	34.8
5	36	37.2	38.4	39.7	41	42.3	43.6	44.9	46.2	47.6
6	49	50.4	51.8	53.3	54.8	56.3	57.8	59.3	60.8	62.4
7	64	65.6	67.2	68.9	70.6	72.3	74	75.7	77.4	79.2
8	81	82	84.6	86.5	88.4	90.3	92.2	94.1	96	98
9	100	102	104	106	108	110	112	115	117	119
10	121	123	125	128	130	132	135	137	139	142
11	144	146	149	151	154	156	159	161	164	166

TABLE 6—Gear Service Factors

Application	Service Factor
Generator (normal application)	1.0
Pumps	
Centrifugal (general service)	1.1
Gear	1.5
Water works	1.5
Centrifugal-hot oil	1.5
Pipe line	1.5
Rotary—lobe type	1.7
Reciprocating	1.7
Descaling (without surge tank)	2.0
Fans and Compressors	
Sliding vane compressor (Fuller)	1.2
Forced-draft fan	1.3
Centrifugal compressor	1.3
Induced draft fan	1.5
Industrial blower (repeated starting and stopping cycle such as in steel mill)	1.5
Nash compressor	1.7
Reciprocating compressor	1.7
Lobe-type compressor	1.7

Application	Service Factor
Miscellaneous	
Paper machine	1.1
Line shaft	1.1
Belt or rope drive for other than reciprocating apparatus	1.1
Belt or rope drive for reciprocating apparatus	1.3
Jordans	1.5
Pulp beaters	1.5
Cane cutters	1.7
Cane shredder	1.7
Pulverizers	1.7
Reciprocating apparatus	1.7
Sugar mill	1.7
Chipper	2.2

For applications not listed use factor listed above for nearest equivalent service.

Step 1. Determine Fan Specific Speed from Equation (1).

a. From Figure 1, the density of air at 105° F or 565° R and an elevation of 1,000 feet above sea level is 0.0675 pounds per cubic foot.

b. Equivalent Static Pressure from Equation (3) is:

$$ESP = 20'' \times \frac{0.075}{0.0675} = 22.2 \text{ inches}$$

c. From Table 2 Static Pressure Factor, $(ESP)^{\frac{3}{4}} = 10.3$

d. Fan Specific Speed from Equation (1):

$$N_s = 1800 \frac{\sqrt{122{,}500}}{10.3} = 61{,}165 \text{ rpm}$$

Step 2. Calculate Fan Wheel Diameter from Equation (2). From Figure 3 (Note: N_s at 61,165 is off the scale of Figure 2) the Fan Rating Factor, K = 0.275 for a double width, double inlet fan.

$$\text{The wheel diameter} = \frac{\sqrt{122{,}500} \times 0.275}{2.12} = 44.35 \text{ inches}$$

Note: $(ESP)^{\frac{1}{4}}$ is also obtained from Table 2.

Step 3. Determine Fan Horsepower Requirement from Equation (4).

$$HP = \frac{0.000157 \times 122{,}500 \times 20}{0.85} = 452.5 \text{ hp}$$

Step 4. Select Gear Set

a. From Table 6, the service factor rating is 1.3

b. The speed ratio of the turbine driver to the fan is 4,000/1,800 = 2.22

c. From Table 5, the Ratio Speed Factor, F is 10.2

d. Gear Index from Equation (5)

$$= \frac{452.5 \times 1.3 \times 10.2}{4000} = 1.5$$

Step 5. Determine Cost of Complete Fan Unit

a. Cost of a 44-inch diameter wheel fan from Table 1 = $8,200

b. Cost of Built-In Gear Set from Table 5 = $2,500

c. Cost of Turbine Drive from Figure 4 = $6,800

Total Purchased Cost of Fan Unit = $17,560

It should be noted that this cost of a coupled gear set would have been $2,805 plus an additional $250 for a high-speed coupling. ##

HOW TO ASSIGN COSTS

How to Estimate Operating Costs

Here is a method for estimating operating costs which is useful in making preliminary economic evaluations

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This method of calculating operating costs, along with the literature references, permits fairly accurate estimates during project evaluation. All cost items normally associated with operating a process unit per se are included. However, costs for blending, compounding, packaging, shipping, etc., are not included since those activities are not normally a part of the process unit operation, even though they may be quite pertinent to the profitability of the project and are sometimes included in such calculations.

The analyses of the effect of operating capacity and of variances in operating labor and investment show these to be important factors. The estimator will be well advised to consider these as a part of his cost analysis in order to prevent a more complete picture to management. This will in turn permit more intelligent decisions to be made with respect to choosing the preferred projects for further research and development.

Much general information available in part from several references is consolidated here and a rigid method of estimating operating costs is presented with more detail than has generally been covered by others.[1, 2, 3, 4, 5, 5a]

Why, When, and How Research Projects Are Evaluated. Research management today allocates a portion of its budget to basic and fundamental research. It requires little economic justification for this work. However, the picture is different when it comes to de-

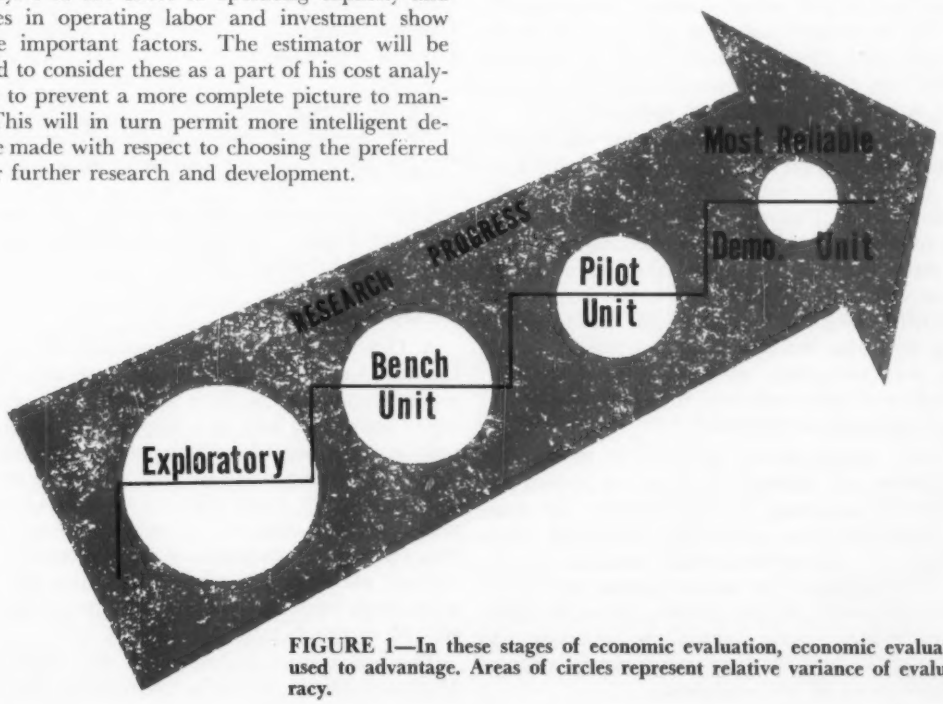

FIGURE 1—In these stages of economic evaluation, economic evaluation can be used to advantage. Areas of circles represent relative variance of evaluation accuracy.

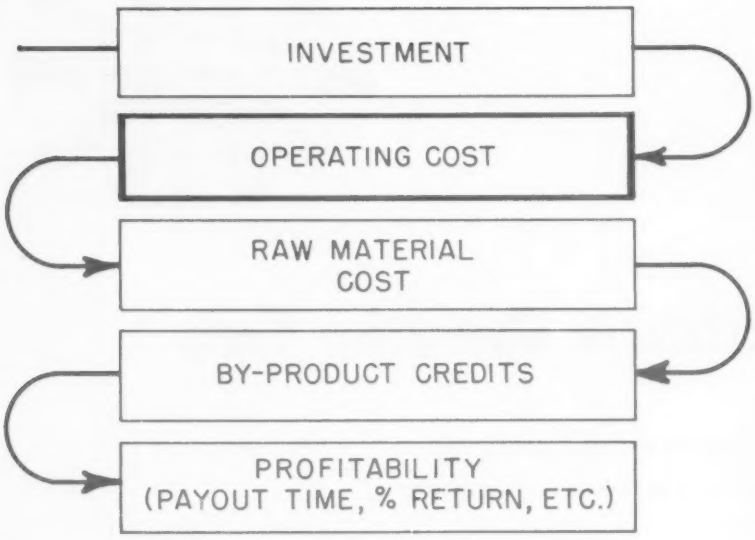

FIGURE 2—Operating cost is covered in detail in this study of the basic factors in the cost estimating chain.

velopment research. Before undertaking an extensive development program, management wants a sense of proportion as to what success of the project could mean in terms of economic potential in the event it is developed to completion.

The typical research organization in the petroleum industry has no shortage of development projects. The major problem is to judiciously select those which may ultimately mean the most to the company. The use of economic evaluation is often an aid in making this selection but it does not entirely control management's decisions. The economic picture is just one of many factors considered. The evaluation basically consists of estimating the potential economic attractiveness of the project in a typical commercial application.

Figure 1 shows the stages of development where economic evaluation is often used to an advantage. The evaluation accuracy increases as the project progresses. The various stages in Figure 1 may be looked upon as "Stairsteps to Success," with each succeeding step being much more difficult than the preceding one. For each project which finally reaches the last step there are many others which fall by the wayside due to either technical or economic limitations. If the project shows advantages over competing processes at the demonstration level, a recommendation is usually made to place it into commercial operation.

The over-all considerations involved in most economic evaluations of research projects are shown in Figure 2. Broadly speaking, the basic factors requiring economic treatment are: investment, operating cost, raw materials cost, by-product credits, and an expression of the profitability to be expected upon successful commercial application of the project. Accurate estimation of each item in the "chain" is important. A substantial error in any of these can seriously distort the final conclusions of the evaluation.

A detailed method of estimating the "operating cost" part of the chain will be emphasized, and a bibliography of additional information on individual cost items will be included.

How to Estimate Operating Cost. The estimated cost of operating a process unit should at least cover direct charges such as labor, catalyst, utilities, and maintenance and repairs. In addition, a complete estimate should also include certain other items such as depreciation, insurance, taxes, and overhead costs. Several of these may be estimated from past records of similar units, if specific data are not available for the unit in question.

A detailed method of estimating the operating cost can best be shown by a hypothetical example. For example, assume the process to be a fixed-bed catalytic unit. Typical equipment includes heaters, reactors, fractionators, stabilizers, compressors, heat exchangers, pumps, etc. It is assumed that the following information was given or estimated previously:

Thruput, Fresh Feed (no recycle)	= 20,000 BPOD* 6,600,000 BPY*
Operating Days per Year	= 330
Down for Repairs, Days per Year	= 35
Capital Investment**	= $10 MM
Liquid Hourly Space Velocity	= 2.0 v/hr/v***
Utilities, Steam	= 1,480 M lbs/day
Utilities, Power	= 4,000 kw-hr/day
Utilities, Water	= 7,000-M gal/day
Utilities Fuel Gas	= 1,400 BPOD****

* BPOD = barrels per operating day
BPY = barrels per year
** Does not include cost of original catalyst load; this expense is charged as an operating cost item over the life of the catalyst (See Catalyst)
*** 2.0 v/hr/v = 2 bbl/hr of fresh feed per barrel of catalyst
**** Fuel gas is expressed in terms of a "standard barrel" which is equivalent to 6,400,000 Btu

The calculation of each operating cost item is shown in Table 1 and a discussion of the basis for each calculation is presented below.

1. Operating Labor

a. Direct. These are the personnel who actually run the unit for three shifts per day, such as stillmen, controlmen and helpers. It is assumed that one stillman, two controlmen, and two helpers are assigned to the unit in question. Wessel[5b] provides a method of estimating operating manpower on the basis of plant capacity. Nelson[6] shows relative wage rates and typical manpower requirements for various refinery units, various refinery departments and for complete refineries. Haines[7] also shows a method of estimating labor requirements from a detailed breakdown of the components of each job.

The wage rates in this case are assumed to be: $3.02/hr/stillman, $2.82/hr/controlman, and $2.62/hr/

helper. These rates are chosen basis the average hourly earnings of $2.82 for petroleum refining workers given by Crass.[8]

The annual labor charge for each operator class is obtained by multiplying the number of operators per shift by the wage rate times 8760 hours per year to provide operating wages for 365 days. Even though the unit will actually be in operation for only 330 days in the year, unit operators are required for the remaining 35 days while repairs are made.

An additional 20 percent is added to account for supervision. This charge provides for the unit's proportionate share of a shift foreman, area supervisor, etc. These men are present on all three shifts per day and are responsible for overseeing the operation of several units in a particular area. A distribution of manpower types for several industries has been published.[9]

b. Test and Inspection. This accounts for labor from the plant service group which usually arrives at the unit just as it is being shut down for test and inspection. They check pipe wall thickness, visually inspect the conditions of large lines and vessels, etc. The unit operators work very closely with these people by clearing lines, steaming out vessels, approving welding permits, etc.

The amount of test and inspection labor required is a function of the operating characteristics; the cost increases as the erosion and corrosion characteristics of the operation become more severe. There is little published information on these specific costs, so the estimator will have to rely on experience with similar units. A charge of 1¢/Bbl of fresh feed is assumed here; this amounts to $66,000/yr. Nelson[10] has presented limited information on turnaround labor requirement (includes both test and inspection and labor repairs).

c. Total. The total operating labor charge for items (a) and (b) is $212,200/yr or 3.2¢/Bbl of fresh feed.

2. General Supplies. This item covers general materials and supplies used in normal unit operations. Examples are canvas and filter paper, lubricating oils for compressors and pumps, rags and fluids for cleaning, buckets, make-up refrigerant, small tools, pump packings installed while the unit is operating and hydrogen needed for pressuring and starting up a unit. Although this charge is not usually large, it varies considerably depending on the nature of the operation. A figure of 0.5¢/Bbl of charge is assumed here.

3. Fuel. Nelson[11,12] gives typical fuel gas requirements for various process units and for complete refineries. The requirement for this operation is about 0.07 Std Bbl/Bbl of fresh feed which amounts to 1400 BPOD. A price of $/Std Bbl is assumed here for a total cost of $462,000/yr. (A standard barrel of fuel gas is equivalent to 6,400,000 Btu). When the gas is primarily methane, this amounts to a little over 16¢/Mscf which is a fairly typical price for gas located near a refinery.[13,14]

Gas transmission cost can be important when the refinery is located a considerable distance from a gas field. For example, if gas is purchased at the well for 16¢/Mcf and transmitted to the refinery about 1000 miles away, the total delivered cost will amount to about 30¢/Mcf (equivalent to about $1.92/Std Bbl with transmission cost estimated to be about 14¢/Mcf mile). The heating value of a standard barrel of gas approximates that of a barrel of Bunker C fuel oil. Thus, the refiner must make an economic balance between using purchased gas or refinery fuel oil to make

TABLE 1—Estimated Operating Cost for 20,000 BPOD Unit

	$/Yr.	¢/Bbl. Fresh Feed
1. Operating Labor		
a. Direct		
1 Stillman/shift = (1 x $3.02/hr) (8760 hrs/yr) = 26,500		
2 Controlmen/shift = (2 x 2.82) (876C) = 49,400		
2 Helpers/shift = (2 x 2.62) (8760) = 45,900		
Sub Total (equivalent to $13.90/hr.) = $121,800		
Add 20 percent for Supervision = 24,400		
TOTAL $146,200		
b. Test and inspection $0.01/Bbl FF (6,600,000 Bbl FF/Yr) = 66,000		
c. Total (sum of a and b) =	212,200	3.2
2. General Supplies = $0.005/Bbl FF (6,600,000 Bbl FF/Yr) =	33,000	0.5
3. Fuel = 1400 Std Bbls/Day x $1.00/Std Bbl x 330 Days/Yr =	462,000	7.0
4. Steam = 1480 M lbs/Day x 330 Days/Yr x $0.40/M lbs =	195,400	3.0
5. Electric Power = 4000 kw-hr/Day x 330 days/Yr x $0.008/kw-hr =	10,600	0.2
6. Water = 7000 M gal/Day x 330 days/Yr x $0.02/M gal =	46,200	0.7
7. Catalyst = 73,000 lbs/yr x $1.00/lb =	73,000	1.1
8. Chemicals = $100/Day x 330 Days/Yr =	33,000	0.5
9. Maintenance and Repair Labor = 0.025 x $10,000,000 =	250,000	3.8
10. Maintenance and Repair Materials = 0.015 x $10,000,000 =	150,000	2.3
11. Plant Services Sum of 1 and 9 = $462,200 0.85 x $462,200 =	392,900	6.0
12. Depreciation		
a. Proposed Unit = 0.05 x $10,000,000 = $500,000		
b. Steam, Power, and Water Facilities		
Steam = $0.02/M lb (1480 x 330 M lb/yr) = $9,800		
Power = $0.0005/kw-hr (4000 x 330 kw-hr/yr) = 700		
Water = $0.005/M gal (7,000 x 330 M Gal/yr) = 11,500		
$22,000		
c. Total (sum of a and b) =	522,000	7.9
13. Property Insurance and Taxes		
a. Proposed Unit = 0.015 x $10,000,000 = $150,000		
b. Steam, Power, and Water Facilities		
Steam = 0.005/M lbs (1480 x 330 M lb/yr) = $2,400		
Power = $0.0001/kw-hr (4000 x 330 kw-hr/yr) = 100		
Water = $0.001/M Gal (7000 x 330 M Gal/yr) = 2,200		
$4,700		
c. Total (sum of a and b) =	154,700	2.3
14. Personnel Insurance and Taxes = 0.15 x $462,200 =	69,300	1.0
15. Overhead = 0.24 x $462,200 =	110,900	1.6
16. Royalty =	0	0.0
17. Total Operating Expense	$2,715,200	41.1¢

up that amount of fuel which is not available from gas produced in cracking operations at the refinery. It follows also that the value to be placed on refinery gas, often used as raw material in petrochemical operations, will be equivalent to the cost of purchased gas or the value of refinery fuel oil, since these will have to be used for heating in the event that refinery gas is routed to petrochemicals.

4. Steam. The steam requirement for this process is 1480 M lbs/day or 74 lbs/Bbl of fresh feed. Nelson gives typical steam requirement values for a number of different types of complete refineries[11, 15, 16] different refining units,[17] pumps,[13] and distillation equipment.[18] The price of steam depends primarily on the price of fuel used in the steam generation step, often accounting for about 70-85 percent or more of the total cost. Nelson[19] gives information on typical costs of steam and also shows the effects of reusing parts of the steam. A price of 40¢/M lbs is assumed here which amounts to $195,400/yr. This is assumed to be a direct cost and does not include depreciation, insurance and taxes (handled in items 12 and 13). The use of direct cost here is an optional procedure. The total cost could be used instead, in which case charges for depreciation, insurance and taxes would not be entered under items 12 and 13.

5. Electric Power. Skrotzki[20] gives typical power costs. Nelson also gives costs[21, 22] and requirements[15, 16, 22, 23] for various units and equipment. The costs vary over a fairly wide range, primarily because they are largely a function of fuel costs which vary considerably. This process uses 4000 kw-hr per day and a direct power cost of 8 mills per kw-hr is assumed for a total of $10,600/yr. The use of direct cost here is an optional procedure. The total cost could be used instead, in which case charges for depreciation, insurance, and taxes would not be entered under items 12 and 13.

6. Water. Water requirement for this process is about 7MM gal/day. This is primarily water which is circulated through the unit and back to cooling towers, with only a small amount being used as either make-up or process water. The cost of cooling water varies considerably depending on the refinery circumstances. Nelson[24] gives water requirement data for a distillation unit; he also shows the range over which circulating water cost can vary.[25] A direct cost of 2¢/thousand gallons is assumed, making a total of $46,200. The use of direct cost here is an optional procedure. The total cost could be used instead, in which case charges for depreciation, insurance and taxes would not be entered under items 12 and 13.

7. Catalyst. The space velocity is 2.0 v/hr/v. At a fresh feed rate of 20,000 bpod (834 bbls/hr), the catalyst inventory is: 834 bbls/hr ÷ 2.0 bbls/hr/bbl catalyst = 417 bbls of catalyst. Assuming a catalyst density of about 175 lbs/bbl, this amounts to an inventory of about 73,000 lbs of catalyst. Assuming that the catalyst has a life of one year, this is equivalent to a life of: (20,000 × 330 Bbls/yr FF ÷ 73,000 lbs of catalyst) = 90 bbls FF/lb of catalyst, which is reasonable for many catalytic operations. Collier[26] gives additional information on catalyst life and cost for both petroleum and chemicals operations.

A catalyst cost of $1/lb is assumed; thus the total cost becomes $73,000/yr. Baral, et al[27] show typical catalyst costs for various refining processes.

8. Chemicals. This caption covers miscellaneous chemicals which may be required in the operation. A distinction is normally made between "chemicals" and "raw materials." Chemicals (charged here as an operating expense) are materials such as caustic, ammonia, various corrosion inhibitors, etc. Such materials are not part of the unit products; they merely aid in the operation. On the other hand, if a chemical is charged to a reactor in the same sense that other raw materials are charged and if this chemical appears in the final product or by-product, then it is looked upon as a "raw material" and is handled as such in the cost analysis; it does not appear as an operating cost. Nelson[12,28] has published chemical requirements and costs for both unit processes and complete refineries.

It is assumed that the miscellaneous chemicals requirement for this unit is about $100/day ($33,000/yr).

9. Maintenance and Repair Labor. Most repairs are made when the unit is shut down for test and inspection. Glauz[29] gives a general discussion on various ways to estimate repair labor and gives some detail on labor required for various individual equipment items. Nelson[30] shows maintenance costs (labor and material) for a wide variety of refining processes. The results are expressed as percent of replacement value per year and range from 2.4 to 5.7. Maintenance costs are very difficult to estimate with accuracy from historical data, since company accounting records are often not adequate for this purpose. Also, more often than not the new unit is not exactly like one on which historical maintenance data are available. For the purpose of preliminary cost estimation, "percent of investment" estimate is normally satisfactory. It is assumed that this process has a labor repair charge of about 2.5 percent of investment per year. This amounts to $250,000/yr.

10. Maintenance and Repair Materials. This covers the cost of maintenance and repair materials. It is assumed to be about 1.5 percent of investment per year for a total of $150,000/yr.

11. Plant Services. The charges included under this caption cover the cost of various shops, storehouses, cafeterias, analytical and testing laboratories, fire department, personnel vacation and benefit plans, guards, police protection, etc. Newton[2] shows these to be about 60 to 70 percent of direct labor expense, supervision, and maintenance charges. Sweet[1] says that these costs may be as high as 100 percent of the estimated direct operating labor, supervision, maintenance, and supplies. In this case, it is assumed they amount to about 85 percent of items 1 and 9 for a total of $392,900/yr.

12. Depreciation. Grant[31] discusses the various concepts of depreciation. In general it can be stated that

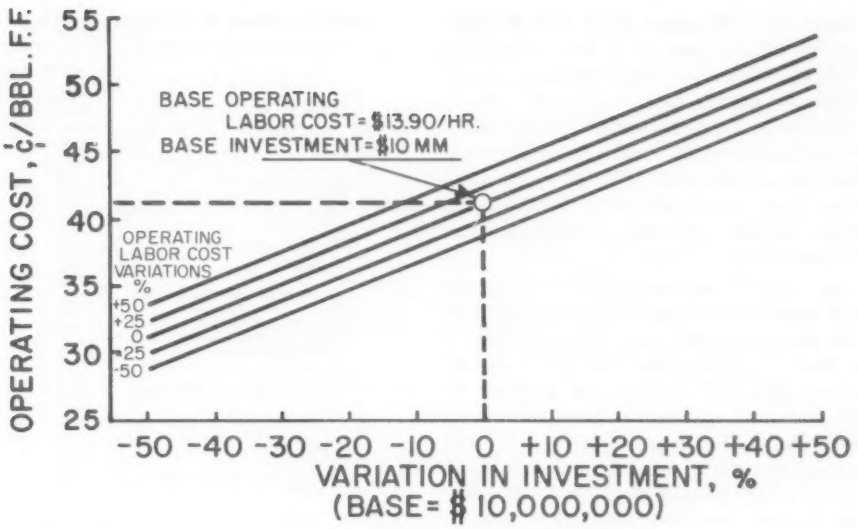

FIGURE 3—Effects of variations in operating labor cost and investment on operating cost show that a given percentage variation in investment is much more critical than the same variation in labor cost for this particular case.

a charge for depreciation as an operating cost item represents that money which can be deducted from profits each year over the life of the unit so that at the end of its life the total money deducted will be exactly equal to the investment made originally. This in principle enables the investor to stay in business perpetually. Tables of useful lives of depreciable property can be found in Bulletin "F" of the United States Treasury Department, Internal Revenue Service (IRS Publication No. 173).

Grogan[32] compares the straight line depreciation method with the declining balance and sum of year's digits methods. The latter two methods allow a more rapid recovery of investment capital on a tax-free basis during the earlier years of a unit life, while the straight line method allows a uniform recovery, say 5 percent per year, over the same life period.

a. Depreciation of Process Unit Investment. A straight line depreciation rate of 5 percent per year ($500,000/yr) is assumed for this process, with no allowance for salvage value. Since this represents money charged as an operating cost but not actually spent, it will enter into a payout time calculation as will be shown later.

b. Prorata Share of Depreciation on Steam, Power, and Water Facilities. All units using plant utility facilities must not only pay for the direct costs as shown in items 4, 5 and 6, above but also must bear a proportionate expense of the depreciation on these facilities. This may range from 5 to 25 percent of the direct costs. The rates assumed for this case are 2¢/M lbs for steam, 0.05¢ kw-hr for power and 0.5¢/M gal of water. The total of these items is $22,000/yr.

13. Property Insurance and Taxes. Insurance and taxes on property are most often estimated jointly. Process insurance covers fire, storm damage, etc. Process taxes are not income taxes but involve such things as real estate taxes, etc. These charges are broken into two categories in a manner similar to that above.

a. Insurance and Taxes on Process Unit Investment. A figure of about 1.5 percent of investment per year is used by most estimators; this amounts to $150,000/yr for this case.

b. Prorata Share of Steam, Power and Water Facilities. Rates assumed are 0.5¢/M lbs of steam, 0.01¢/kw-hr of power, and 0.1¢/M gallons of water; the total cost is $4,700/yr.

14. Personnel Insurance and Taxes. This charge covers expenses such as hospitalization insurance, social security taxes, unemployment insurance, etc. It is assumed that these amount to about 15 percent of direct labor (items 1 and 9) for a total of $69,300/yr.

15. Overhead. This covers costs such as: industrial and public relations, executive and administrative personnel, design and process engineers, purchasing department, legal activities, comptroller department. These are estimated to be about 15 to 35 percent of total direct labor (sum of items 1 and 9). This charge is combined with plant services (item 11) by some estimators.[1, 5a] A figure of 24 percent is assumed in this case for a total of $110,900/yr.

16. Royalty. This caption covers expenses incurred when it is necessary to pay a royalty for using a process. It is assumed that this is a private process development and that there are no royalty costs. Nelson[33] and others[34] give typical royalty charges for petroleum and chemical processes, respectively.

17. Total Operating Expense. From Table 1, the total annual operating expense (sum of items 1 through 16) is $2,715,200/yr, which is equivalent to 41.1¢/Bbl of fresh feed.

Variation in Estimates of Labor Cost and Investment. The question often arises as to how important it is to have a firm estimate of both operating manpower and investment; that is, how much will a given percentage variance in each of these affect the estimated operating cost. Using the above example as the base case ($10 million investment and $13.90/hr operating labor cost), other cases were calculated to show the effect of variations in both operating labor costs and investment. The results are in Figure 3.

This shows that a given percentage variation in investment is much more critical than the same variation in labor cost for this particular case. For example, if the investment had originally been estimated to be $12,500,000 rather than $10 million (an increase of 25 percent), the operating cost would have risen from 41.1¢/Bbl to 46.3¢/Bbl (13 percent increase). Thus, a 25 percent error in investment can mean about a 13 percent error in the total operating cost estimate. Likewise, an increase in the total operating labor expense of 25 percent would raise the operating cost from 41.1 to 42.4¢/Bbl (about 3 percent increase). This observation will be different for other processes having different ratios of operating labor to investment.

It is advisable in most cases to study the effects of the above variances since they could have significant effects on the profitability of the project.

Profitability. Discussion of many ways to express profitability will not be given here, since this has been accomplished by many other authors.[35, 36, 37, 38] However, it is appropriate to show how to handle the depreciation item in one type of profitability calculation: "Payout Time."

Assume that the following credit and debit information is given; the investment is $10 million and the payout time is obtained as shown:

Credits:	$/Yr
Value of Products	$17,400,000
Value of Byproducts	600,000
Total	$18,000,000
Debits:	
Operating Cost	$ 2,715,200
Raw Material	12,700,000
Interest on Borrowed Capital	500,000
Total	$15,915,200

Payout Time:

Gross Profit = $18,000,000 — $15,915,200	=	$2,084,800
Income Tax (52%)	=	—1,084,100
Net Profit	=	1,000,700
Depreciation Allowance (Item 12a, Table I)	=	500,000
Total Funds Available After Taxes		$1,500,700

Payout Time = $10,000,000 ÷ 1,500,700 = 6.7 yrs.

Depreciation ($500,000) was originally included as item 12a in the operating cost which is charged as a debit when calculating gross profit; this has the effect of setting aside $500,000 tax-free from the gross profit. Then this $500,000 is added to the net profit to make up the total funds available for paying out investment.

TABLE 2—Effect of Operating At Various Capacities

Item	Class I	Operating Cost, ¢/Bbl FF		
		100% Cap	80% Cap	60% Cap
2	General Supplies	0.5	0.5	0.5
3	Fuel	7.0	7.0	7.0
4	Steam	3.0	3.0	3.0
5	Electric Power	0.2	0.2	0.2
6	Water	0.7	0.7	0.7
7	Catalyst	1.1	1.1	1.1
8	Chemicals	0.5	0.5	0.5
16	Royalty	0.0	0.0	0.0
	Total	13.0	13.0	13.0
	Class II (Pessimistic Case)			
1, a 1, b	Direct Operating Labor T & I Operating Labor	3.2	4.0	5.3
9	Maintenance and Repair Labor	3.8	4.8	6.4
10	Maintenance and Repair Materials	2.3	2.9	3.8
11	Plant Services	6.0	7.5	10.0
14	Personnel Insurance & Taxes	1.0	1.2	1.7
	Total	16.3	20.4	27.2
	Class III			
12	Depreciation	7.9	9.9	13.2
13	Property Insurance & Taxes	2.3	2.9	3.8
15	Overhead	1.6	2.0	2.7
	Total	11.8	14.8	19.7
17	Total Operating Expense	41.1	47.2	59.9

Variable, Semi-Variable, and Fixed Operating Costs. Sometimes it is necessary to estimate the operating cost of a unit when it is running at various percentages of capacity. Calculations in Table 1 are based on 100 percent capacity operation and the operating cost is 41.1¢/Bbl FF.

Table 2 shows the case where the unit is operating at 100 percent, 80 percent, and 60 percent of capacity all during the year (330 days per year). The operating cost items are split into the following classes:

► **Class I**—The annual cost ($/Yr) for these items is directly proportional to total throughput. Thus, the unit cost ($/Bbl FF) is constant.

► **Class II**—These are annual costs which may or may not vary with throughput. For example, if the unit operates at only 60 percent of capacity (12,000 rather than 20,000 bpod), will the annual operating labor cost be only 60 percent as great as that at 100 percent capacity? This depends on the nature of the operation, union agreements, flexibility of labor pool, etc. A pessimistic case (shown in Table 2 and Figure 4) would be to assume that all the Class II annual cost items would remain the same regardless of throughput, thus the cost per barrel of fresh feed is inversely proportional to thruput.

An optimistic case (shown in Figure 4) would be to assume that these unit costs (¢/Bbl FF) are constant and do not vary with thruput; that is, they fit the Class I definition.

► **Class III**—The annual cost for these items is fixed. Thus, the unit cost (¢Bbl FF) varies inversely with thruput. For example, annual property taxes and insurance costs are the same, regardless of the operating capacity.

Figure 4 shows the effect of percent capacity operation on unit operating cost for both the pessimistic and

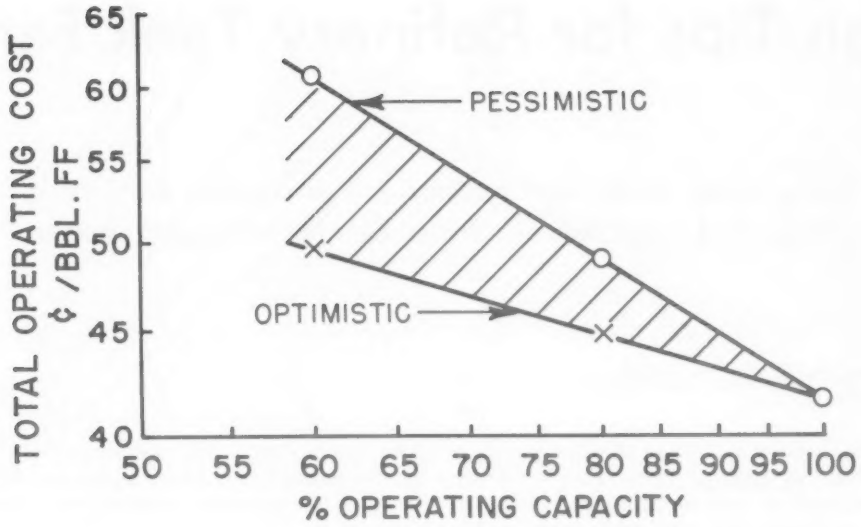

FIGURE 4—Operating capacity has this effect on operating cost for this particular case.

optimistic situations possible with Class II costs. At 60 percent of capacity, the cost lies between 49 and 60¢/Bbl. The 49¢/Bbl figure can be approached only by having enough control over the Class II annual costs to make them reduce in the same proportion that capacity is reduced (hold the same unit cost, ¢/Bbl).

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Several co-workers contributed to the development of the above information. Acknowledgments are particularly due H. S. Walz, J. W. Poulter, Chris Smith, B. F. Smith, J. H. Vergilio and F. R. Douglas. Also, sincere appreciation is expressed to Texaco Inc. for permission to present this article.

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Key Words for Indexing

Burden	Evaluation	Operators
Capacity	Fuels	Profits
Catalyst	Inspection	Repairing
Costs	Insurance	Research
Depreciation	Labor	Taxes
Economics	Maintenance	Utilities
Estimates	Operating	Wages
Estimating		

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Dickens

Design Tips for Refinery Tank Farms

Using crude yield, sales forecast and production data, tanks, pumps and miscellaneous items can be reasonably selected

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Taylor, B. C., Canada

Three variables control the design of refinery storage tanks, pumps and miscellaneous items. They are crude yields, the sales estimate and the production forecast. These can be predicted with reasonable accuracy because the economics have been worked out during the process design evaluation stage.

Tanks—Service and Size. Storage tanks can be divided into the following services: rundown, component, sales, feed, multiple service or swing, and miscellaneous —or a combination of two or more of these.

- **Rundown Tanks.** These are small tanks that receive product from the process units. They are filled, checked to see if the product is on-specification and then pumped to component tanks. It is believed that these are not necessary now, as the unit streams are well checked and usually if a stream goes off-specification the product can be blended out. If not, it can be slopped and rerun.

- **Component Tanks.** These are tanks for storing separate process products such as alkylate, reformate, arctic diesel. For distillates, these can sometimes be used as sales tanks as well. It is desirable to have the bulk of your storage in component storage because of the varying composition of finished blends during the various seasons and because of the varying amounts of individual components.

- **Sales Tanks.** These tanks are finished product tanks. With inline blending, these are becoming unnecessary.

- **Feed Tanks.** These are unit charge tanks.

- **Multiple service tanks.** These are normal component tanks that are piped so that they can be used for gasoline components or distillate service or two other distinct services.

- **Miscellaneous tanks.** These are such items as slop tanks.

The sizing of storage tanks is quite complicated. A very rough guide is that for every barrel per day of crude charge there should be approximately 100 Bbls. of storage. Figure 1 shows how this applied for all Canadian refineries making a full range of products. The storage and crude capacity of 33 refineries are plotted in this figure. It is believed that by following the methods outlined below that this ratio can be reduced.

TIPS ON TANK SIZING

- Unless there is a special need, keep tank size at 5000 Bbls. or greater. The cost of small tanks is excessive. Figure 2 shows the approximate installed cost of an API cone roof tank.
- Put most of gasoline storage into component storage. Have at least two tanks per component—one for running into the other for testing then transferring. Size by operating forecast is outlined in the last tip. As a rough guide, have about 3-4 weeks storage at maximum production for each gasoline component.
- Keep gasoline sales tanks small. Size each tank for 4 days storage at maximum production of gasoline—one day for transferring, one day for mixing leading, etc., one day for testing and one day spare for rework if necessary. Have two tanks per gasoline grade to be sold. With inline blending these tanks can be omitted but the component tanks have to be enlarged to take care of volume stored in these tanks.
- Size distillate tanks by operating forecast as outlined in the last tip below. As a rough guide for prairie Canada, require about 3 months maximum production storage. Distillate component tanks can normally be used as sales tanks.
- For miscellaneous tanks such as cycle oil, kerosene, etc., size for two weeks of maximum production. These items can normally easily be transferred and a large storage is not necessary. For slop tank, use two percent of monthly crude charge.
- Feed tanks vary considerably. For crude with a pipeline supplying the refinery, 8-10 days storage should be ample. When receiving by tanker or truck, increase this depending on possibility of freeze ups or road bans, etc. Unit charge tanks—size tanks on basis of expected length of possible shutdown, exclusive of turnarounds, about 2 days maximum, i.e. Time to fix any equipment.
- Develop a forecast of production sales and inventory with the refinery running at design capacity for a 12-

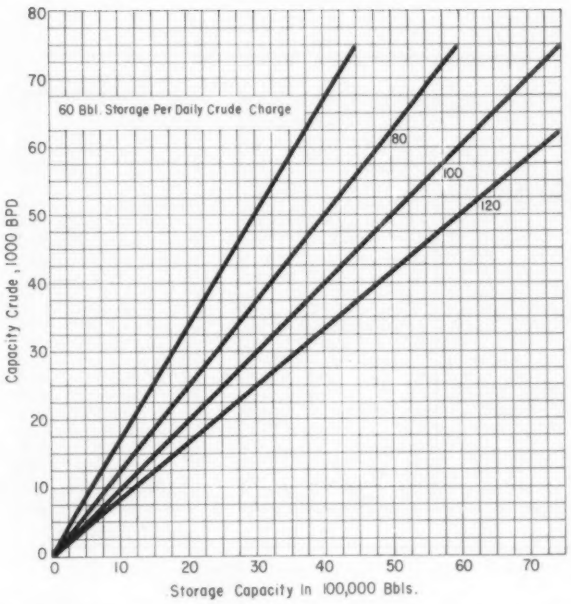

FIGURE 1—Crude charge vs. storage capacity for 33 Canadian refineries.

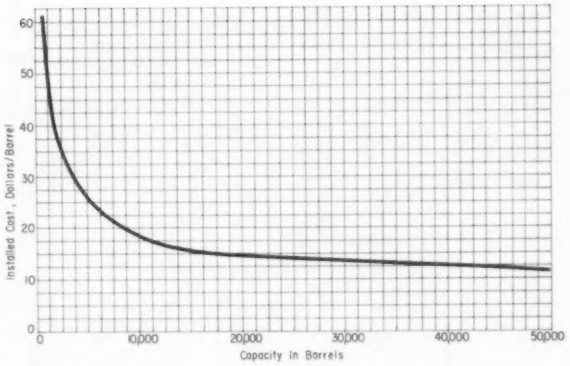

FIGURE 2—Approximate installed cost of API cone roof tank.

month period. Assume in winter building for gasoline sales and in summer selling from inventory. The example given lists several possible assumptions for various products. If no data is available, the assumptions shown in the example can be used as a basis. It should be noted that the operating forecast shown has been simplified somewhat. The refinery is run at full capacity the entire period. Generally, the tankage should be sized for the unit design capacities unless these are not going to be reached for some years.

SAMPLE PROBLEM

Size the necessary tankage for a new 10,000-bpd crude charge refinery. The refinery has a crude unit, a reformer, a catalytic cracker, an alkylation unit and a vacuum unit. The crude yield is shown in Table 1. An outside source of isobutane is assumed.

The two main intermediate products that are stored and further processed are reformer feed, 23 percent of crude, and gas-oil, 35 percent of crude.

Production Data. Table 2 gives the estimated daily, monthly, and yearly production of the several items. From this production data an operating forecast (Table 3) can be developed.

Using this forecast and the guides previously listed, the tankage required is shown in Table 4.

Note: In a refinery not subject to such wide swings in product demand, the tankage required would be considerably less. A check should be made to see whether some gasoline and distillate tankage could be combined. In the case outlined, however, the maximum gasoline storage requirement occurs at the same time as distillates.

TABLE 1—Crude Yield and Special Data for 10,000-BPD Example Refinery

Yield Data	Components Made From Crude Percent of Crude	Saleable Products Percent of Crude
LSR Gasoline	5.0	.....
Butane	0.7	.....
Reformate	20.0	.....
CC Naphtha	19.0	.....
Alkylate	12.0	.....
Total Gasoline	.....	56.0
Arctic Diesel	15.0	13.0
Winter Diesel	.....	2.0
Summer Diesel	.....	13.0
Diesel Base	9.0	.....
Light Cycle Oil	4.0	.....
Bunker	1.0	1.0
Asphalt	10.0	10.0
Total	95.7	95.0

SPECIAL DATA:

1. **Sales**
   - Gasoline: Winter (Nov.-Feb.) = 60 Percent of Summer Volume; Spring & Fall (Mar.-Apr; Sept.-Oct.) = 80 Percent of Summer Volume
   - **Diesels**: Arctic all winter, last month of fall, first of spring. Summer Diesel—All summer, last month of spring first of fall. Winter Diesel—Sell Spring and fall only.
   - **Bunker**: Sell consistently through the year.
   - **Asphalt**: Sell 5 months, June to October.
2. **Blending and Product Distribution Data:**
   Gasoline Sales ⅓ #1 Gaso., ⅔ #2 Gaso., #3 Gaso. Volume quite small—Sales 2,000-3,000 Bbls/Month in late spring, early fall—provide minimum sales tankage only.
   Summer Diesel = Made of ¼ Arctic, ¾ diesel base, plus 50 Percent of LCO produced.
   Arctic Diesel = Blend into this 50 Percent of LCO produced.
   Winter Diesel = 50 Percent Arctic, 50 Percent Summer Diesel.
3. **Turnarounds:**
   There is ½ month turnaround in the last of August.
4. **Status of Storage**
   Assume storage empty at end of maximum sales period (i.e. November November 1 for asphalt, September 1 for gasoline, April 1 for Arctic Diesel, October 1 for Summer Diesel). Other as shown in operating forecast.

TABLE 2—Estimated Production for 10,000-BPD Example Refinery

	Feed and Intermediate Products		Components		Saleable Products		
	B/Day	B/Month	B/Day	B/Month	B/Day	B/Month	B/Year*
Crude	10,000	300,000	.....	.....	.....	.....	.....
Butane	.....	.....	70	2,100	.....	.....	.....
LSR	.....	.....	500	15,000	.....	.....	.....
Reformer Feed	2,300	.....	.....	.....	.....	.....	.....
Reformate	.....	.....	2,000	60,000	.....	.....	.....
CC Naphtha	.....	.....	1,900	57,000	.....	.....	.....
Alkylate	.....	.....	1,200	36,000	.....	.....	.....
Gasoline	.....	.....	.....	.....	5,600	168,000	1,930,000
Arctic Diesel	.....	.....	1,500	45,000	1,300	39,000	450,000
Winter Diesel	.....	.....	.....	.....	200	6,000	69,000
Summer Diesel	.....	.....	.....	.....	1,300	39,000	450,000
Diesel Base	.....	.....	900	27,000	.....	.....	.....
LCO	.....	.....	400	12,000	.....	.....	.....
Gas Oil	3,500	.....	.....	.....	.....	.....	.....
Bunker	.....	.....	100	3,000	100	3,000	34,500
Asphalt	.....	.....	1,000	30,000	1,000	30,000	345,000

* Allows for Turnaround.

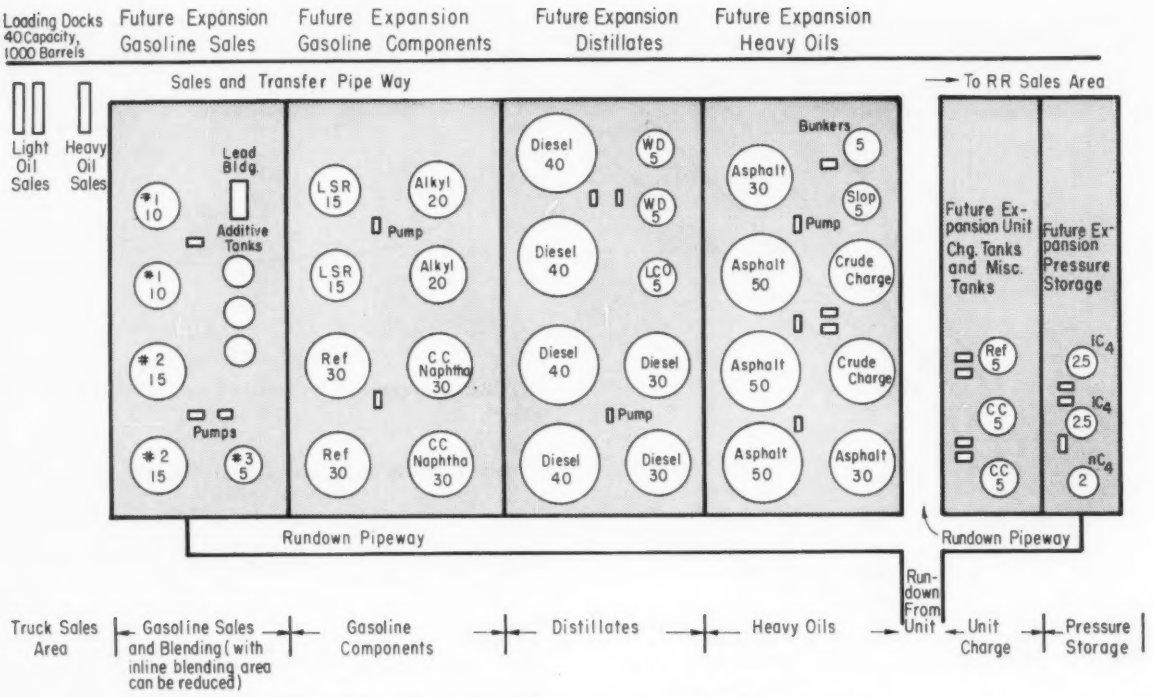

FIGURE 3—Typical tank farm layout for 10,000-bpd refinery.

TANK FARM LAYOUT

The tank farm should be laid for the following:

- Minimum cost thus minimum piping
- Ease of expansion
- Ease of change of service
- Prevention of contamination of products.

To accomplish this, a good means is illustrated in Figure 3. In this example the tanks of similar service are grouped in rows with allowance for expansion, the pipeways outside the dykes are kept to a minimum, pumps are located near the tanks they serve, and run-down lines and transfer lines are run through dykes. Similarly, fire service water can be run the same way, although the whole tank farm should be looped.

Tank Farm Piping. Try to obtain a minimum amount of piping with maximum separation of products. Here are some rules:

- Use separate lines for each product with double blocks and bleed between same. You can use the same line for transferring components going into a finished blend. For instance, for the components in the example, use one component line for #1 gasoline and one line for #2 gasoline. Continue #2 line to #3 gasoline.
- Always use single suction lines. Manifold at pump if necessary. Keep suction lines as short as possible.
- Use separate pipeways outside dykes very sparingly.
- Locate pumps near the tanks that they service.
- Do not provide rundown connections to multiple tanks. You can hook up temporary means of transfer if necessary.
- Connect tanks to one pump only. If pump fails and cannot be fixed in suitable time, you can hookup a temporary system.

Tank Farm Pumps. Nearly all pumps are centrifugal except for heavy oil in such services as crude unloading, asphalt, etc., which are generally gear or reciprocating, positive-displacement type pumps.

Capacity

Loading Pumps. Size for at least 300 Imperial gpm or 350 US gpm, when loading into trucks. When shipping by pipe line, determine this separately.

Transfer Pumps. Size so that transfer to the largest tank is complete in 24 hours or less. For example, for a gasoline component given in the sample problem, the maximum sales tank required is 15,000 barrels.
Size $15{,}000/24 = 625$ bph $= 440$ US gpm. Say $= 500$ US gpm

Combined Service. (i.e. Mixing, Transfer, Loading etc.) Size for service requiring maximum capacity.

For diesel pumps in sample problem size as follows:

For loading required, 350 US gpm. For transfer to winter diesel tank or summer diesel,

$$\frac{10{,}000\ (42)}{24\ (60)} = 290 \text{ US gpm}$$

TABLE 3—Operations Forecast for 10,000-BPD Example Refinery

(All quantities in 1,000 of barrels. All inventories on first of each month)

	WINTER				SPRING			SUMMER			FALL	
	Nov.	Dec.	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.
Gasoline												
Production	168	168	168	168	168	168	168	168	168	82	168	168
Sales	120	120	120	120	160	160	200	200	200	200	160	160
Storage	16	64	112	160	208	216	224	192	160	128	E	8
Arctic Diesel												
Production	45	45	45	45	45	45	45	45	45	22.5	45	45
Receipt from LCO	12	12	12	12	6	6	0	0	0	0	0	9
Transfer to SD	0	0	0	0	0	8.7	21.6	21.6	21.6	21.6	8.7	0
Transfer to WD	0	0	0	....	1.0	7.5	0	0	0	....	8	9
Sales	93.7	93.8	93.8	93.2	37.5	0	0	0	0	0	0	37.5
Storage	151.7	115.0	78.2	41.4	4.7	E	34.8	58.4	81.6	105	105.9	144.2
Winter Diesel												
Receipts	0	0	0	0	20	15	0	0	0	0	16	18
Sales	0	0	0	0	20	15	0	0	0	0	16	18
Storage	E	E	E	E	E	E	E	E	E	E	E	E
Summer Diesel												
Production as Base	27	27	27	27	27	27	27	27	27	13.5	27	27
Receipts AD	0	0	0	0	0	8.7	21.6	21.6	21.6	21.6	8.7	0
Receipts LCO	0	0	0	0	6	6	12	12	12	6	12	3
Transfer to WD	0	0	0	10	7.5	0	0	0	0	8	9	0
Sales	0	0	0	0	0	37.5	93.7	93.8	93.8	93.7	37.5	0
Storage	30	57	84	111	128	155.7	159.9	126.8	93.6	60.4	(0.2)	E
Asphalt												
Production	30	30	30	30	30	30	30	30	30	15	30	30
Sales	0	0	0	0	0	0	0	69	69	69	69	69
Storage	E	30	60	90	120	150	180	210	171	132	78	39

Maximum inventories are underlined.

TABLE 4—Tankage Required for 10,000-BPD Example Refinery

ITEM	Base For Determining	Required Bbls. Total Tankage	Actual Bbls. Number & Size	Remarks
#1. Gasoline	Four Days at Maximum production for each tank. Have 2 Tanks.	15,800 (7,400 each)	2–10,000	Round off capacity to nearest 5,000 greater. If inline blending is used, transfer this volume to component Tanks.
#2. Gasoline	Four days at maximum production for each Tank. Have 2 Tanks.	29,800 (14,900 each)	2–15,000	
#3. Gasoline	Sales quite small. Use minimum tank.	.....	1– 5,000	
	Total Gasoline Sales	.....	55,000	
Gasoline Components	Maximum Gasoline Storage Required = 224,000 Bbls. Component Storage 224,000–55,000 = 169,000 Bbls. Component production averages 5,600 bpd. Equals 30 days storage for each component.			
LSR	30 Days	15,000	2–10,000	
Reformate	30 Days	60,000	2–30,000	
FCCU Naphtha	30 Days	57,000	2–30,000	
Alkylate	30 Days	36,000	2–20,000	
	Sub-Total Component Storage	.....	180,000	
	Gasoline Storage (Sales and Components)	.....	235,000	
Distillates	Continually switch services on tanks from arctic to summer and back. Also can use winter diesel tanks for other services.			
Summer & Arctic Diesel	Maximum tankage required is in May. Cannot use gasoline tankage as this at a maximum too.	194,700	4–40,000 2–20,000	This number of tanks for ease in transferring from summer to arctic and vice versa.
Winter Diesel	Same as gasoline sales tanks (as product normally all blended)—4 days maximum each tank (sales—20,000/month)		2– 5,000	Use minimum size for each tank.
Light Cycle Oil	Size for two week maximum production	6,000	1– 5,000	Can transfer easily thus don't need any larger tankage.
	Total Distillates	.....	2,15000	
Heavy Products				
Bunker	Size for one month's production. This is a low priced product and normally disposed of quickly or not made.	3,000	1– 5,000	Minimum Tank.
Asphalt	Size by operating forecast	210,000	3–50,000 2–30,000	5 tanks for flexibility.
	Total Heavy Products	.....	215,000	
Miscellaneous				
Slop Tank	Size for 2 Percent of monthly crude run 300,000	6,000	1– 5,000	This should be OK for this service.
Charge Tanks				
Crude Charge Tanks	Use 8 days storage	80,000	2–40,000	
Unit Change Tanks	.....	.....	.....	.....
Cat Cracker charge	Use 2 day's Charge	7,000	2– 5,000	
Reformer Charge	Use 2 day's Storage	4,600	1– 5,000	
	Total of Charge Tanks	.....	100,000	
Pressure Storage				
Isobutane	This refinery uses outside isobutane. Assumes 7 days storage for 700 bpd required.	4,900	2– 2,500	Sphere, do not use minimum of 5,000
Normal-Butane	Month production 2,100 Bbls. Assume 2,000 Bbls. sphere.		2,000	
	Total Pressure Storage	.....	7,000	
	Total Tankage Required	.....	772,000	

For Mixing—Capacity required for mixing quite low—for 4-hour circulation with jet mixing, 100 US gpm. Thus, size pump for loading.

Number of Pumps and Location. To reduce suction lines and suction, pumps should be located inside dykes, close to the tanks from which they are pumping. Figure 3 shows the locations of the pumps required for the 10,000 bpd refinery.

Each sales service should have its own pump unless it is very infrequently used. Normally it should not be spared, however, means should be provided that by using a simple spool piece another pump can spare it easily.

For transfer pumps—use one pump for about four tanks and locate it in the middle of the four tanks.

For asphalt service, use at least one pump for every two tanks. Size similar to diesel pumps (i.e. used for loading, transfer and mixing).

Example. Table 5 shows how to find the pumps required for the 10,000 bpd refinery whose storage was determined in the sample problem.

Loading. Here are some comments on loading docks:

- Provide separate loading lines for each product
- Provide temperature compensated set-stop meters with ticket printers for each product
- Provide each line with an air eliminator and a screen
- Provide remote starting either by an electric switch starting pump or a pressure switch that automatically starts the pump on a drop in pressure. (You need a system that keeps line pressure up when the pump is not in use.)

TABLE 5—Pumps Required for 10,000-BPD Example Refinery

	No. Reqd.	Capacity U.S. gpm	How Capacity Determined	Remarks
#1 Gasoline	1	350	Sales	
#2 Gasoline	1	350	Sales	
#3 Gasoline	1	350	Sales	Pipe to use as spare for #1 and #2 gasolines, if needed
CC Naphtha & Reformate Transfer	1	500	Transfer	
LSR & Alkylate Transfer	1	500	Transfer	
Diesel Transfer & Sales	1	350	Sales	No. determined by tank layout (see Figure 3)
Diesel Transfer & Sales	1	350	Sales	
Winter Diesel Sales & Transfer LCO Transfer	1	350	Sales	
Bunker Sales & Slop Transfer	1	350	Sales	Use also for one asphalt tank (see Figure 3)
Asphalt Sales & Transfer	2	350	Sales	
Crude Charge	2	320	Unit Charge	
FCCU Charge	2	110	Unit Charge	(These tanks might be located nearer to the unit and not in farm.)
Reformer Charge	2	75	Unit Charge	
iC4 Charge	2	25	Unit Charge	
Butane Transfer and iC4 unloading	1	250	Make smaller than other transfer as amount transferred small.	

MISCELLANEOUS TANK FARM FEATURES

Dykes. Normally require a dyke volume at least equal to the tank volume inside the dyke—generally practice is 1½ volumes. Tanks less than 5,000 barrels can be grouped inside a single dyke. Sometimes making the dykes wide enough to drive on is a good feature for both safety and maintenance.

Dyke Drains. Dykes should be suitably drained and kept drained. Drainage should be well away from the process units, not towards them.

Tank Appurtenance. All tanks should be equipped with the following:

- Ground reading level gage.
- Dial thermometer with at least an 18-inch stem.
- Water draw off connection with antifreeze valve, etc.
- Pump out connection with a small sump in the tank.
- Gauge hatch for sampling and check gaging—minimum size should be six inches.
- If the flash point of stored material is 100°F or below, combination vacuum breaker and vent is needed. If the flash point is greater than 100°F, just provide a vent. Run vent to side of tank and preferably to the ground. Size vent for adequate release of vapours on heating, say 6-inch minimum.
- Ground level manhole.
- Top of tank manhole with safety release vent.
- Outside spiral staircase.

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Key Words for Indexing

Charge Tanks
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Slop Tanks
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Tanks

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Younger

Acrylonitrile—Petrochemical Prodigy

Bring yourself up-to-date with this summary of acrylonitrile manufacturing processes, chemical reactions and end-use markets

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Monsanto Chemical Company, Texas City, Texas

Major markets for acrylonitrile—fibers, rubber and plastics—look bright. New products capitalizing on acrylonitrile's versatile and unique properties should show accelerated growth in the 1960s. Although consumption of acrylonitrile leveled off last year, its long term growth rate should exceed that of the chemical industry as a whole.

Acrylonitrile has been one of the outstanding petrochemicals of the past decade. This versatile chemical remained relatively unknown from the time of its discovery in 1893 by Moureu until the need for oil resistant rubbers brought about its commercialization at the beginning of World War II. Since then, ever-broadening usage has given rise to a rapidly-expanding acrylonitrile economy. New acrylonitrile processes and plants and new products based on acrylonitrile have been announced with regularity. This review of acrylonitrile is an up-to-date summary of processes, chemical reactions and markets in this fast-moving field.

Acrylonitrile Manufacturing Processes

Processes for acrylonitrile may conveniently be divided into the following categories based on raw materials.

1. Acetylene-based processes
2. Propylene-based processes
3. Ethylene oxide process
4. Miscellaneous

ACETYLENE-BASED PROCESSES

Over half of the acrylonitrile produced in the U.S. today is made by the reaction of acetylene with hydrogen cyanide. As shown in Table 1, companies employing this process are Monsanto, American Cyanamid, Goodrich and DuPont.

TABLE 1—U.S. Acrylonitrile Producers

Company	Process	Estimated 1961 Capacity, MM lbs/yr.
American Cyanamid Fortier, La.	Acetylene-HCN	100
B. F. Goodrich Calvert City, Ky	Acetylene-HCN	35
Monsanto Texas City, Texas	Acetylene-HCN	100
Union Carbide Institute, W. Va.	Ethylene Oxide-HCN	70
Sohio Chemical Lima, Ohio	Propylene-NH_3-Air	45
DuPont Memphis, Tenn.	Acetylene-HCN	50
Beaumont, Texas	Propylene-NO (?)	50[1]
	TOTAL	450

[1] Under construction

The acetylene-based process was developed in Germany in the early forties by the I. G. Farben interests. Small plants were built at Ludwigshafen and Leverkusen to provide acrylonitrile for Buna N oil-resistant rubbers needed in the German war effort. Detailed process information from these plants became available after the war.[1,2] The key to the successful commercial synthesis of acrylonitrile from acetylene was the development of an aqueous cuprous chloride catalyst similar to that discovered by Nieuwland of Notre Dame University for the conversion of acetylene to monovinylacetylene. The stoichiometric equation for the process may be written as follows:

$$C_2H_2 + HCN \xrightarrow[\text{Catalyst}]{\text{CuCl}} \underset{\text{Acrylonitrile}}{CH_2=CH-CN}$$

Following World War II, many American companies did research and development work on acrylonitrile processes. As will be discussed later, American Cyanamid built the first commercial acrylonitrile plant in the U.S. in 1940, using ethylene oxide and hydrogen cyanide as raw materials. The first American plant employing an acetylene-based process was completed by

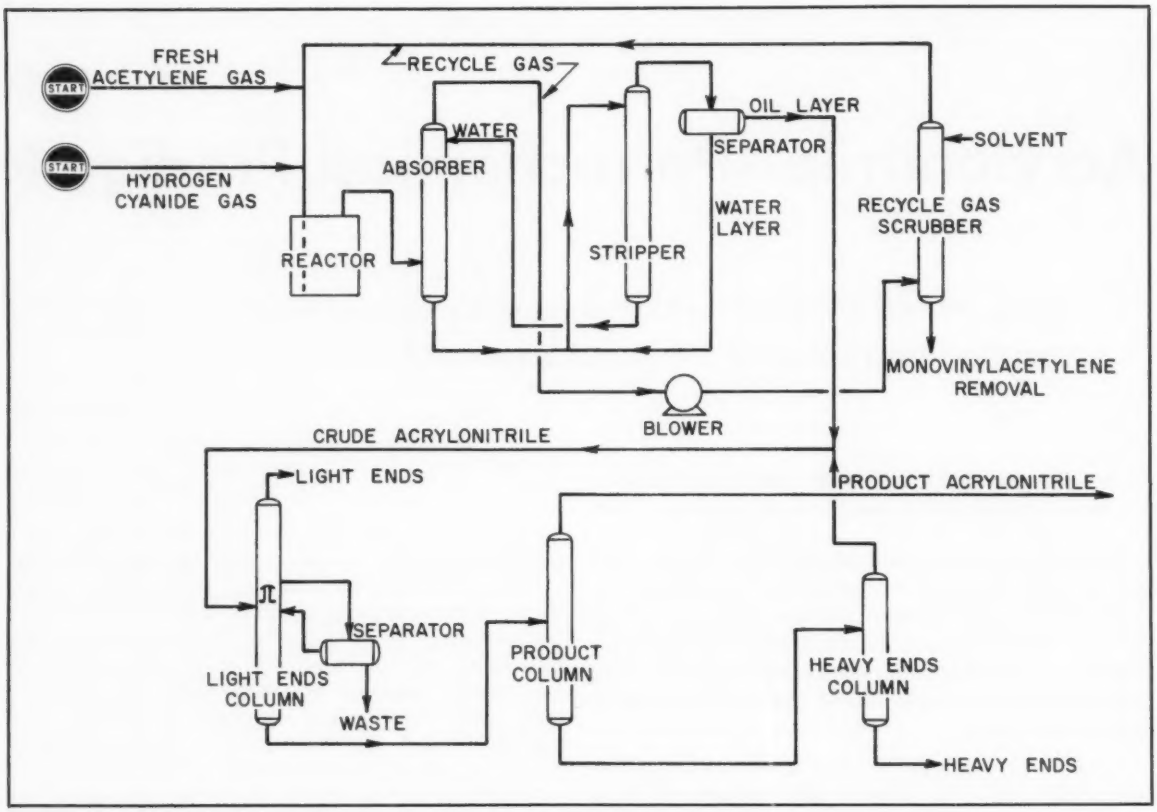

FIGURE 1—Starting with acetylene and hydrogen cyanide, American Cyanamid uses this acrylonitrile process at its Fortier plant near Avondale, La.

Monsanto in 1952 at Texas City. American Cyanamid subsequently built a plant employing the acetylene process at Fortier, La., in 1954 and a third acetylene-based unit was installed by Goodrich at Calvert City, Ky., in 1955. DuPont's new plant near Memphis, Tenn., was completed late in 1960.

The process used by American Cyanamid at their new Fortier plant was described at the World Petroleum Congress in 1955,[3] and is broadly similar to the German process described in the FIAT reports cited previously. A generalized process description based on these references and pertinent patents is as follows. Figure 1 is a flow sheet for the process.

Description—Acetylene and hydrogen cyanide are reacted in the presence of the aqueous cuprous chloride catalyst at 80-90° C and 2-5 psig at the top of the reactor. The molar ratio of acetylene to hydrogen cyanide in the reactor feed is about 6/1. The reactor effluent is cooled then passed into an absorber where acrylonitrile is recovered as a dilute (1-3 percent) solution in water.

Unreacted acetylene, inerts and higher acetylenes (e.g., monovinyl- and divinylacetylene) which form in the process go overhead in the absorber and subsequently to a solvent scrubbing operation which removes the higher acetylenes before the acetylene is recycled to the reactor.

The small amount of unreacted HCN in the reactor effluent and water-soluble by-products are dissolved in the dilute aqueous solution of acrylonitrile leaving the absorber. This solution is fed to a column where acrylonitrile and lower boiling impurities are stripped from the water.

The resulting crude acrylonitrile, which contains about 80 percent acrylonitrile, is fed to a light ends column where relatively volatile impurities such as a acetaldehyde are removed, and then to a drying column where the remaining water is separated by azeotropic distillation. The bottoms from this column go to a product column where product acrylonitrile is obtained as the overhead. The bottoms from the product column are fed to a heavy ends column where acrylonitrile is recovered and recycled; the bottoms which contain high boiling impurities such as cyanobutadiene are sent to waste disposal.

Yields and Problems. The yield of acrylonitrile from the reaction step is 75-80 percent based on the acetylene consumed and 85-90 percent based on HCN fed. A major drawback to the process is the relatively large number of by-products which form in the reactor. Not only do these by-products consume raw materials but they also cause difficulties in the recovery and purification of acrylonitrile. As shown in Table 2, the typical sales specifications for acrylonitrile allow only trace

TABLE 2—Typical Sales Specifications for Acrylonitrile

Characteristic	Min.	Max.
Acidity (as acetic acid)		20 ppm
Aldehydes (as acetaldehyde)		100 ppm
Apppearance	Clear and free of suspended matter	
Color (APHA scale)		15
Distillation Range (760)		
first drop distills at	74.5° C	
97% distills at		78.5° C
Divinylacetylene		5 ppm
Hydrogen Cyanide		5 ppm
Iron		0.2 ppm
Methyl Vinyl Ketone		100 ppm
Non-volatile Matter		0.01%
Peroxides (as H_2O_2)		1 ppm
Refractive Index	1.3882	1.3891
Stability (oxygen bomb)	4 hours	
Water	0.25%	0.45%
Inhibitor (monomethyl ether of hydroquinone)	35 ppm	45 ppm

amounts of impurities. Removal of impurities to meet these specifications requires efficient separation processes and effective process control. It is of interest that certain impurities such as divinylacetylene and methyl vinyl ketone have boiling points relatively close to acrylonitrile and numerous patents have been issued on various processes to remove these compounds.[4,5,6] Considerable research has also been devoted to the development of inhibitors to prevent or minimize polymer formation in the distillation equipment used to purify acrylonitrile.[7,8]

Another problem in the Nieuwland catalyst process is the decline in catalyst productivity or activity which occurs during operations. This decline is due both to the formation of catalyst "tars" and to the buildup of ammonium chloride in the catalyst from hydrolysis of HCN, acrylonitrile and other nitriles. The rates of formation of these materials vary with acetylene purity, gas feed rate, catalyst acidity and other factors. Regeneration processes which remove catalyst impurities have been described in FIAT and BIOS reports and in various patents.[1,9,10]

Anhydrous Catalysts. Since the water in the Nieuwland catalyst contributes both to by-product formation through hydration reactions and to loss in catalyst activity from hydrolysis reactions, the development of anhydrous catalysts has been the focus of much research. The use of organic solvents instead of water is claimed to reduce or eliminate the formation of acetaldehyde and other hydration products. Some of the solvents claimed in the patent literature are polar organic compounds such as dimethyl formamide,[11] pyrrolidone,[12] and adiponitrile.[13] Non-aqueous solvents have not been reported to be in commercial use.

High temperature, vapor phase reaction of acetylene and HCN over supported catalysts is another approach to avoid the disadvantages of the aqueous catalyst process. Processes employing both fixed[14] and fluidized bed[15] reactor systems have been reported. Catalysts described are generally alkali and alkaline earth salts (carbonates, hydroxides, cyanides) on supports such as charcoal. Since diluents appear to be helpful the use of dilute acetylene obtained from commercial processes, e.g. Sachsse or Wulff, is claimed to be feasible,[16] and thus offers a potential savings in acetylene purification costs. High acrylonitrile yields (up to 98 percent) are claimed in the patent literature on vapor phase processes. Definitive data on catalyst life are not available but various techniques of preparing the catalyst are claimed to result in economic catalyst usage rates. No commercial acrylonitrile, plant employing a vapor phase process with acetylene and hydrogen cyanide as raw materials has been reported.

PROPYLENE-BASED PROCESSES

The most significant development in the acrylonitrile industry in recent years has been the commercialization of a propylene-based process by Standard Oil of Ohio (Sohio). Early in 1959 Sohio announced the construction of a new plant at Lima, Ohio, employing this process. Recent reports indicate the plant came on-stream in the summer of 1960. Estimated capacity is 40-50 MM lbs/year.

DuPont has also developed a propylene-based process for acrylonitrile. A plant employing this process is currently being built at Beaumont, Texas. Estimated capacity of this plant is also about 50 MM lbs/year.

The Sohio process has been described in U.S. and Belgian patents[17,18] and recently by Veatch of Sohio's Research Department.[19] In this process acrylonitrile is produced from propylene, ammonia and air in a one-step catalytic reaction. The stoichiometric equation for the process may be written as follows:

$$C_3H_6 + NH_3 + 3/2\ O_2 \rightarrow CH_2{=}CH{-}CN + 3H_2O$$

The process employs a supported molybdenum-based catalyst in a fluidized bed reactor. Operating temperature is about 450° C and pressures are less than three atmospheres. The ratio of propylene to ammonia to oxygen is about 1:1:2. Either oxygen or air can be used but air is preferred from an economic standpoint.

Conversions and yields from the Sohio process were disclosed in the patents cited above. In examples given in these patents yields of "useful products" of up to 81 percent on a nitrogen basis were reported, while conversions to acrylonitrile of 33 percent on a carbon basis and 65 percent on a nitrogen basis are listed. By-products from the process which may be classified as "useful" are acetonitrile, acrolein and hydrogen cyanide. The yield of acetonitrile is 10-15 percent of the acrylonitrile produced. Sohio plans to recover and sell this by-product acetonitrile. Other by-products made in the process are CO and CO_2, which result from uncontrolled oxidation of propylene.

The Sohio process is attractive from a raw material standpoint because refinery propylene (40 to 90 percent pure) and fertilizer grade ammonia may be used as feed stocks. The impure propylene may contain propane and lower hydrocarbons including ethylene, but should be free of butylenes since these higher olefins react to form undesired by-products.

Recovery and Purification. Another attractive feature claimed for the Sohio process is a comparatively simple recovery and purification system as opposed to the complex recovery systems required for some hydrocarbon

oxidation processes. The reactor effluent is scrubbed with water to separate fixed gases and unreacted hydrocarbons, which go either to a stack or to hydrocarbon recovery equipment. Acrylonitrile is recovered from the absorption water by stripping and is then purified by distillation. Product quality compares favorably with that of acrylonitrile from the conventional acetylene process. By-product acetonitrile is converted to a high purity product by drying and by a final distillation step.

DuPont Process. The propylene-based process of DuPont has been described in a 1956 patent.[20] This process differs from the Sohio process in that propylene and nitric oxide (NO) are used as raw materials rather than propylene, ammonia and oxygen (air). However, since nitric oxide is made from oxidation of ammonia, the DuPont process may be considered as a two-step process based on propylene, ammonia and oxygen. The stoichiometric equation for the process may be expressed as follows:

$$4C_3H_6 + 6NO \rightarrow 4CH_2 = CH - CN + N_2 + 6H_2O$$

The reaction is carried out at about 700° C in the presence of a supported silver catalyst. Yields and conversions are said to be comparable to those obtained in the Sohio process. It is believed that the new plant being built at Beaumont will use the propylene-NO process but DuPont has not confirmed this.

Other companies have also patented propylene-based processes for acrylonitrile. For example, Distillers Co. Ltd. has recently been issued a Belgian patent on a process employing propylene, ammonia, oxygen and water as reactor feeds.[21] The reaction is carried out at about 500° C over supported molybdenum oxide. Distillers has several earlier patents on conversion of acrolein, made by propylene oxidation, to acrylonitrile by reaction with ammonia and oxygen.[22] However, the newer one-step propylene-based processes have obvious advantages over a two-step process in which acrolein is produced and separated and then is reacted with ammonia.

ETHYLENE OXIDE PROCESS

The ethylene oxide process for acrylonitrile may be represented by the following equations:

$$H_2C - CH_2 + HCN \xrightarrow{\text{Catalyst}} HOCH_2CH_2CN$$

(ethylene cyanohydrin)

$$HOCH_2CH_2CN \xrightarrow[\text{dehydration catalyst}]{\text{Heat}} CH_2 = CH - CN + H_2O$$

The ethylene oxide process was utilized in the first acrylonitrile plant built in this country, by American Cyanamid in Warners, N. J., in 1940. The capacity of this plant was about 25 MM lbs/year. A second ethylene oxide-based plant was built by Union Carbide at Institute, W. Va., in 1952. American Cyanamid shut down the Warners plant after their acetylene based plant at Fortier, La., started operations in 1954. On the other hand, Union Carbide doubled the capacity of their plant in 1958 from 35 to 70 MM lbs/year.

Description—The ethylene oxide process for acrylonitrile has been the subject of numerous patents. In the first step of the process, ethylene cyanohydrin is formed by a liquid phase reaction of ethylene oxide and hydrogen cyanide in the presence of an alkaline catalyst. This reaction is strongly exothermic and a solvent such as ethylene cyanohydrin itself or water is used to aid in controlling the temperature.[23] Various catalysts have been patented. Sterically hindered amines, which do not react with ethylene oxide and are readily separated from the solvent (water) and the cyanohydrin, are claimed to be superior catalysts.[24] Alkaline inorganic salts such as alkali and alkaline earth metal cyanides or hydroxides, may also be employed as catalysts. The use of magnesium salts which are readily removed from the reaction mixture by forming insoluble magnesium carbonate is claimed to result in better recovery of the cyanohydrin.[25] Yields claimed in various modifications of the ethylene cyanohydrin process range up to 98 percent and are believed to be at least 95 percent in practice.

The dehydration of ethylene cyanohydrin to acrylonitrile is a liquid phase reaction carried out at about 200° C in the presence of a dehydration catalyst. Acrylonitrile and water are allowed to distill overhead from the reactor while unreacted ethylene cyanohydrin which distills out is condensed and recycled. The patent literature indicates that sodium formate is a superior dehydration catalyst,[26] although other alkaline salts such as calcium oxide are also suitable.[27] A mixture of sodium chloride and carbon monoxide is also claimed to be an excellent catalyst.[28] The addition of glycol ethers to the reaction mixture as antifoam agents is said to result in higher yields of acrylonitrile.[29] The dehydration reaction is claimed to give acrylonitrile yields as high as 98 percent; as in the cyanohydrin formation reaction, 95 percent yields are believed to be attained in commercial units.

MISCELLANEOUS PROCESSES

The three principal types of processes discussed previously are used commercially. Many other processes have been reported in the literature but have not been commercialized.

Knapsack Process. One of these processes, the so-called Knapsack process, has been operated on a relatively large pilot plant scale in Germany and made available for license by the Knapsack-Griesheim Company. The raw material for this process is lactonitrile, which is made from acetaldehyde and hydrogen cyanide. The process may be represented by the following equations:

$$CH_3CHO + HCN \xrightarrow{\text{Catalyst}} CH_3CHOHCN$$

(lactonitrile)

$$CH_3CHOHCN \xrightarrow[\text{Catalyst}]{\text{Heat}} CH_2 = CH - CN + H_2O$$

Since acetaldehyde is made commercially from either acetylene or ethylene, the Knapsack process may be ultimately based on either of these hydrocarbon raw materials.

The direct dehydration of lactonitrile is accomplished by contacting the lactonitrile with phosphoric acid for a short period at high temperatures.[30] In one example reported, a mixture of lactonitrile, 85 percent phosphoric acid and steam are injected into a reaction furnace at 600-620° C and 100 MM Hg pressure, at a rate to give a contact time of about five seconds. The exit gases from the furnace are cooled to separate aqueous phosphoric acid then scrubbed with water. The acrylonitrile formed is recovered and purified by conventional distillation techniques. Some of the lactonitrile decomposes to acetaldehyde and hydrogen cyanide and these materials are recovered and recycled to the lactonitrile formation step. The ultimate yield of acrylonitrile claimed is about 90 percent based on lactonitrile.

Prior to the development of this technique for direct dehydration of lactonitrile, work was done on an indirect method in which the acetate ester of lactonitrile was prepared then cracked to give acrylonitrile and acetic acid. The latter was recycled to make either ketene or acetic anhydride, which was reacted with lactonitrile to produce the acetate ester. The direct dehydration process appears to be superior to this indirect dehydration process but neither has been put into commercial practice.

The Chemistry of Acrylonitrile

Acrylonitrile, being multifunctional in nature, is an extremely reactive compound. The three distinct groups which constitute acrylonitrile, i.e., nitrile group, carbon-carbon double bond and hydrogen atoms, all undergo many reactions singly as well as in joint reactions involving the other groups of the molecule. Because of the great number of reactions which acrylonitrile undergoes with various compounds as a consequence of its reactive nature, no effort will be made to consider each reaction individually. Rather, examples of reactions by classes of compounds will be given to illustrate the types of reactions which this versatile molecule undergoes.

REACTIONS OF THE CARBON-CARBON DOUBLE BOND

The most numerous reactions of acrylonitrile are those dealing with the carbon-carbon double bond as shown by a "reaction tree" given in Figure 2.

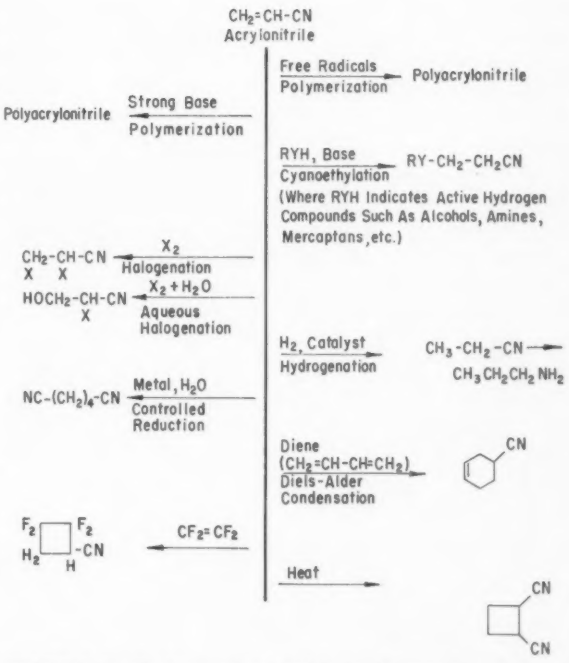

FIGURE 2—Carbon-carbon double bond reactions of acrylonitrile are the most numerous. Examples are shown in this reaction tree.

Polymerization. The most important reaction of acrylonitrile is polymerization.[31-35] Formation of desirable polymers is accomplished by use of a free-radical generating "Redox" system, generally composed of bisulfite-persulfate. This polymerization system produces white, high molecular weight polymers which are useful in the preparation of synthetic fibers. Acrylonitrile is also co-polymerized with other monomers to form copolymers of varying usage. By far, the majority of the acrylonitrile marketed today is used for the preparation of polymers and copolymers. Fibers are the major market for acrylonitrile polymers but other significant uses are in oil resistant rubbers, latex paints and plastics. In this review of the Chemistry of Acrylonitrile, no effort will be made to cover the multitude of polymers and copolymers which can be prepared by free-radical polymerization of acrylonitrile.

Treating acrylonitrile with strong bases such as alkali metal alkoxides causes polymerization of acrylonitrile to form a polymer different in nature from that produced in free-radical polymerizations.[36,37] No uses are known for this base-catalyzed polyacrylonitrile.

Cyanoethylation. "Cyanoethylation"[38,39] is a term used to define a reaction of acrylonitrile with active hydrogen-containing compounds in which a cyanoethyl

group ($-CH_2-CH_2-CN$) is added to the other reacting molecule. In this general reaction, the active hydrogen adds to the nitrile end of the acrylonitrile. double bond while the remainder of the molecule adds to the terminal end of the double bond. If the active hydrogen-containing compound is designated as RYH, the cyanoethylation reaction is illustrated by the following equation. The catalyst is usually a base:

$$CH_2=CH-CN + RYH \xrightarrow{\text{catalyst}} RY-CH_2-CH_2-CN$$

The molecule represented as RYH may be alcohols, amines, thiols, water, hydrogen sulfide, ammonia, carboxylic acid amides, hydrogen cyanide, sulfonamides, silanes, arsines, phosphines, sulfones, and tin hydrides. Several of the groups may be in the same molecule, such as polyhydric alcohols, mixed alcohols-amines, etc.

The reactive groups participating in the cyanoethylation reaction may be part of high polymers such as polyvinyl alcohol, starch, cellulose, cotton, lignin, polypeptides, etc. Reaction conditions may have to be varied because of the non-availability of suitable reaction solvents for these high molecular weight materials, but cyanoethylation can be effected. Cyanoethylation of these well-known materials produces significant changes in their properties. Cyanoethylated cotton, for example, has a higher fiber strength and higher scorch resistance than untreated cotton and is almost completely mildew and rot resistant.

The cyanoethylation reaction also occurs readily with compounds having activated carbon-hydrogen bonds. Such compounds as methyl ketones, aldehydes, alpha-activated (e. g., alpha-monohalogenated) esters and amides and aliphatic nitro compounds have active hydrogen atoms on carbon atoms adjacent to polar groups. In these cases, acrylonitrile generally reacts with each active hydrogen atom; in fact, it is frequently difficult or impossible to stop the reaction short of the completely cyanoethylated product. This type of reaction is typified by the cyanoethylation of nitromethane:

$$CH_3NO_2 + CH_2=CH-CN \xrightarrow{\text{base}}$$

$$O_2N(CH_2-CH_2-CH_2-CN) \xrightarrow[\text{base}]{CH_2=CH-CN}$$

$$O_2N-CH-(CH_2CH_2CN)_2 \xrightarrow[\text{base}]{CH_2=CH-CN}$$

$$O_2N-C(CH_2CH_2CN)_3$$

Acrylonitrile also undergoes the cyanoethylation reaction with certain inorganic salts. Sodium sulfide reacts with two molecules of acrylonitrile, in the presence of water to form thiodipropionitrile; sodium bisulfite reacts to form sodium beta-sulfopropionitrile and ammonium chloride reacts to form iminotripropionitrile.

Halogen acids, such as HCl, add rapidly and almost quantitatively to acrylonitrile in what is called by some a cyanoethylation reaction.[40] No catalyst is needed; the beta-halopropionitriles are formed in high yields.

Halogenation of acrylonitrile at low temperatures readily forms the dichloro—or dibromo—derivatives by addition to the double bond.[41,42,43] Halogenation in aqueous systems readily forms the halohydrin (alpha-halo-beta-hydroxypropionitrile) in typical ethylenic manner.[41,44]

Hydrogenation of acrylonitrile, using mild conditions and standard olefin hydrogenation catalysts, gives propionitrile in high yield.[45] More vigorous conditions may be used to hydrogenate the nitrile group also to form n-propylamine. The nitrile group is more difficult to reduce than is the double bond so hydrogenation of the nitrile to form allylamine can be done only if the olefin group is blocked, for example, by forming a Diels-Alder adduct which can be reverted to starting olefins when the reduction is complete, forming allylamine.[46] Chemical methods of reduction of the nitrile are known but these generally involve a reaction of some type with the double bond, too.[47]

Controlled reduction of acrylonitrile, using certain metals in neutral or slightly alkaline media, effects the reductive coupling of two acrylonitrile units to form adiponitrile.[48]

Diels-Alder Reaction, Condensation with Simple Olefins. Acrylonitrile is one of the more active dienophiles for participation in the Diels-Alder condensation with conjugated diolefins such as butadiene.[49] These reactions proceed readily in high yield to form substituted cyanocyclohexenes. In addition to the Diels-Alder condensation, the double bond of acrylonitrile adds directly to the double bonds in certain simple olefins, most notably the polyhalogenated ethylenes, to form substituted cyclobutanes.[50] Acrylonitrile will condense with itself at about 200° C, under pressure, to form 1, 2-dicyanobutane.[51]

REACTIONS OF THE NITRILE GROUP

General reactions of the nitrile group of acrylonitrile are shown in Figure 3.

Hydration-Hydrolysis. Much work has been done on the hydration/hydrolysis of the nitrile group of acrylonitrile.[37,52,53] Acrylonitrile is readily "hydrated" or partially hydrolyzed to acrylamide by reaction with sulfuric acid monohydrate. Halogen acids also effect this first stage of hydrolysis, forming the acid salts of the amides. Acrylamide is freed from any of the acid salts by simple treatment with an appropriate base and may be isolated from the aqueous solution by extraction with a suitable solvent. In many uses, the acrylamide is polymerized in its aqueous solution without being isolated first.

Acrylonitrile can be hydrolyzed directly to acrylic acid or can be hydrolyzed to acrylamide and then hydrolyzed to acrylic acid by further reaction. The acrylic acid may be recovered from the aqueous solu-

tion by solvent extraction or by use of ion-exchange resins.

Probably of greater interest than simple hydrolysis is alcoholysis of acrylonitrile to form esters. This is generally done by first partially hydrolyzing acrylonitrile to acrylamide which, when further treated with an appropriate alcohol in the presence of the hydrolyzing mineral acid, reacts readily to form the ester.

Condensation with Aldehydes. Under the influence of a strong acid, the nitrile group of acrylonitrile reacts with the carbonyl group of aldehydes to form acrylyl derivatives, as typified by reaction with formaldehyde:[54]

$$H_2C=O + N\equiv C-CH=CH_2 \xrightarrow[H_2O]{H^+}$$

$$H_2C(OH)-N(H)-C(=O)-CH=CH_2 \xrightarrow{CH_2=CHCN}$$

$$CH_2=CH-C(=O)-N(H)-C(=O)-CH=CH_2$$

Other aldehydes react in a similar fashion although many stop at the first stage with elimination of the elements of water between the primary hydroxyl and the nitrogen. These products, again being olefinic in nature, have been evaluated as monomers, but no distinctive properties have been found.

Reaction with Olefins. The nitrile group can be added to olefins in the presence of strong acids.[55] Hydrolysis of the intermediate salts, thus formed, yield N-tertiaryalkyl acrylamides. Primary olefins (unsubstituted olefins) react least readily while olefins with 2, 2-dialkyl substituents react most readily. These products have also been evaluated as monomers and have shown some desirable properties, although they have not presented a profitable product as yet.

The nitrile group, under special conditions, can be caused to participate as the dienophile in a Diels-Alder condensation with dienes.[56] As shown in Figure 3, the products of this reaction are substituted pyridines. While

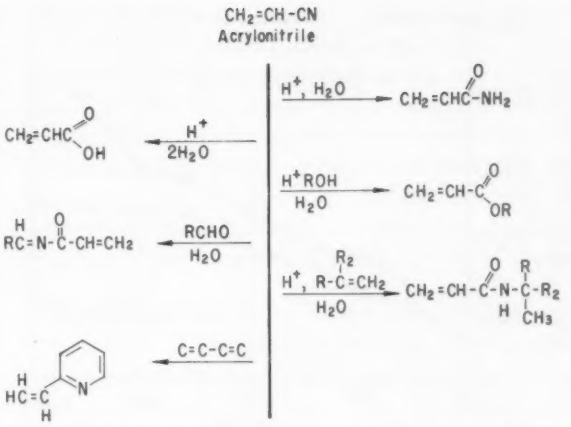

FIGURE 3—Nitrile group reactions are shown in this reaction tree.

there are several such condensations known, this is not currently an economic method of pyridine-analog synthesis.

REACTIONS OF THE HYDROGENS

Reactions of the hydrogen atoms of acrylonitrile are limited almost exclusively to replacement by halogens. While low temperature chlorination forms alpha, beta-dichloropropionitrile by addition,[41,42,43] continued chlorination results in hydrogen replacement, forming essentially all of the possible chlorinated products.[43] High temperature catalytic chlorination of acrylonitrile forms alpha-chloroacrylonitrile in good yield.[39,57] Alpha-chloroacrylonitrile has been evaluated as a monomer and has been found to be quite different from acrylonitrile. The chlorine atom in the polymer is quite reactive and may be exchanged for other groups or removed as HCl by appropriate treatment. No current commercial uses of alpha-chloroacrylonitrile are known.

It can be seen from these examples that acrylonitrile is truly a reactive chemical. While a few commercial products have resulted from its chemical transformation, its current cost has limited most such uses. If the cost of acrylonitrile continues to be lowered, its use as a chemical intermediate will be increased.

Acrylonitrile Markets

During the past decade, acrylic fibers provided the major impetus to the tremendous growth of acrylonitrile. From 1950 through 1959, the acrylonitrile picture changed from almost complete dependency on the nitrile rubber industry to almost the same degree of dependency on acrylic fibers, with large gains in total usage being chalked up yearly. In 1950 there was one producer of acrylonitrile with a plant capacity of 35 million pounds per year. By 1962 there will be six producers with combined plant capacities of approximately

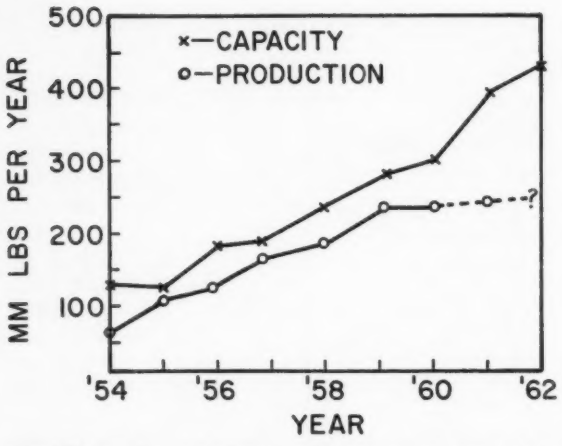

FIGURE 4—Shows the spectacular growth of acrylonitrile capacity and production from 1954 to date.

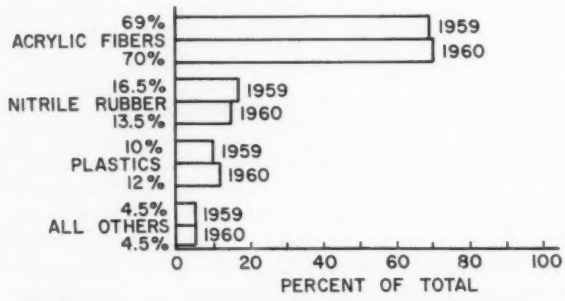

FIGURE 5—Use patterns of acrylonitrile have held steady since about 1950. Notice the slight change in 1959 and 1960 data.

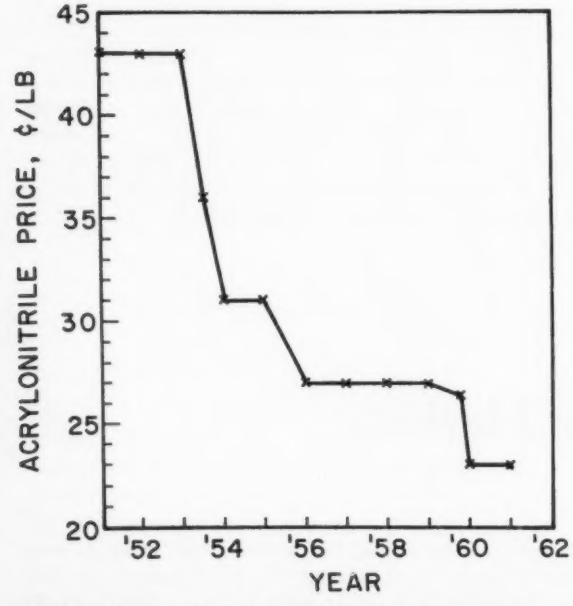

FIGURE 6—As price of acrylonitrile has dropped in past ten years, almost every price change has coincided with increased production capacity.

450 million pounds per year. Figure 4 shows the spectacular growth in acrylonitrile capacity and production from 1954 to date.

Acrylic fibers came from infancy in 1950 to use almost seventy percent of the 200-plus million pounds consumed in the United States in 1959. All other applications, including plastics, synthetic flocculants and chemical derivatives, which were commercially unimportant in 1950, consumed over 30 million pounds in 1959. Acrylonitrile production showed no gain in 1960 over 1959. Likewise, as shown in Figure 5, the use pattern was similar to that of 1959, except that for the first time all non-fiber uses exceeded nitrile rubber. The strength of the acrylonitrile-containing plastics market almost offsets the 1960 decline in nitrile rubber production. Although the failure of acrylonitrile to maintain its past growth rate was caused partly by the business recession in the final half of 1960, there is some indication that the two main users—acrylic fibers and nitrile rubber—will not keep their historic growth rate in the future. However, healthy gains in volume for acrylonitrile should continue with an upturn in the national economy. If so, the growth rate might equal the 27 million pounds per year average recorded during the 6-year period from 1954 to 1960.

Although acrylonitrile exports exceeded 20 million pounds per year during both 1959 and 1960, the outlook for expansion of the export market is unfavorable due to the building of acrylonitrile plants in Europe and Japan.

Since the approximately 450 million pounds of acrylonitrile capacity available in the United States by the end of 1961 will roughly double the quantity expected to be produced, renewed efforts will be made by producers to expand acrylonitrile consumption. As shown in Figure 6, the price of acrylonitrile has decreased sharply in the last ten years. It is of interest that each drop in price has generally coincided with an increase in production capacity.

Acrylic Fibers. Despite the apparent retrenching of the acrylic fibers industry during the 1960-61 recession, producers do not believe these miracle fibers have saturated their markets. Inroads continue to be made into the wool markets, mainly in carpeting and apparel. Acrylic fibers have unique properties such as resistance to acid, heat, rot, mildew, insects, most chemicals and solvents. They are also flexible, strong, rapid drying, and high bulking and have good hand and heat setting characteristics. These features are responsible for the continuing penetration of the fibers into virtually all types of apparel, commercial filters, blankets, padding for cushions, and rugs and carpets.

Chemstrand, DuPont, Tennessee Eastman, Carbide, American Cyanamid and Dow are now sharply com-

peting for position in the acrylic fibers market with DuPont and Chemstrand leading in sales.

Rubber. Nitrile rubber, a butadiene-acrylonitrile copolymer, is a specialty material which is normally used where natural rubber or synthetic styrene-butadiene rubber cannot meet material requirements. Its most interesting properties include resistance to chemicals, oils, most solvents, aging, sunlight, heat, abrasion, moisture and micro-organisms. It is also strong and flexible and has good dielectric properties, low temperature flexibility, good elongation, and low compression set. It is uniquely suited for electrical wire insulation, paper coating, gaskets, adhesives, solvent-resistant hoses and tank linings, self sealing aviation fuel tanks, non-slip and non-marking shoe soles, conveyor belts, non-woven fabrics and many other applications.

However, nitrile rubber competes with such materials as neoprene, chlorinated and chlorosulfonated polyethylene, butyl rubber, silicone rubbers, polyvinyl chloride and fluorinated hydrocarbon polymers in its many end uses. The adhesives application, with its huge growth potential in automotive, aviation and construction, is expected to contribute most to help nitrile rubber regain its growth pattern.

Plastics. Much emphasis will be placed on expansion of the relatively young plastics market for acrylonitrile. New technology is being developed to improve the commercially available styrene-acrylonitrile and acrylonitrile-butadiene-styrene plastics. Development of completely new classes of plastics based on acrylonitrile appears feasible. Acrylonitrile-containing plastics show unique combinations of desirable properties such as good dielectric properties, light stability, high softening temperatures, high tensile and impact strength, and excellent solvent and heat resistance. Producers such as Union Carbide, U. S. Rubber, Dow, Marbon and Monsanto are marketing products which exploit these properties.

Surface Coatings. Coatings manufacturers have not significantly exploited acrylonitrile as a raw material, excluding limited use of nitrile rubber as a coating. Less than one-half of one percent of the acrylonitrile produced today goes into such materials as alkyd resins and latex paints. The coatings industry could conceivably use a much larger percentage of acrylonitrile when the properties of acrylonitrile-containing resins are better recognized.

A combination of the rugged properties of polymers containing acrylonitrile, the dropping price of acrylonitrile, and the size of the potential market favor increasing technical efforts in the area of coatings as well as plastics.

Polyelectrolytes. A growing application for acrylonitrile is in the manufacture of polyelectrolytes (mainly polyacrylamide) for use as flocculating agents in the treatment of water, sewage and industrial waste, and concentration of mineral ores such as uranium. Approximately two percent of the acrylonitrile presently being sold is used in that way. Hydrolyzed polymers of acrylonitrile are also of value as drilling mud additives to prevent loss of water from the mud into the ground.

Cyanoethylation. An additional field hardly touched commercially is the cyanoethylation of cellulose, carbohydrates, and proteins. Modification of basic products such as cotton, starch, paper, jute and leather could provide large potentials for acrylonitrile usage. The use of cyanoethylated dielectric papers is the only one of these natural products being modified in commercial quantities with acrylonitrile. The market for the dielectric papers is growing because their properties of better heat resistance, high dielectric constant and low loss factor enable the increasing of peak loads on electrical transformers without reducing transformer life.

Other cyanoethylated natural products should find markets in the production of rot-resistant fabrics, polyelectrolytes, thickeners, plastics, adhesives, surface coatings and many other materials. For example, a tremendous amount of work has been done on the cyanoethylation of cotton to insure its resistance to rot and mildew. Although the technical goals of the program have largely been achieved, the economics of cotton cyanoethylation and the reluctance of the textile industry to introduce new products to the market have prohibited its commercialization.

Organic Synthesis. The principal chemical derivatives manufactured from acrylonitrile in the U.S. are beta-alanine, from which pantothenic acid, one of the B-Complex vitamins, and its salts are manufactured, and dilauryl thiodipropionic acid, an antioxidant for polypropylene which has been approved for food packaging by FDA.

The patented Japanese process which uses acrylonitrile as a basic raw material for manufacture of monosodium glutamate, a popular meat seasoning and tenderizer, is being studied by U.S. companies. It is still not known if the economics of the synthetic process for monosodium glutamate will prove superior to the currently used processes based on naturally occurring materials.

Pimelic acid, a straight chain C_7 dibasic acid derived from acrylonitrile has potential as a raw material in polyester and polyamide fibers and in resins and diester plasticizers.

A quaternized derivative of pyrimidine which can

be prepared from acrylonitrile shows promise in controlling coccidiosis in poultry.

Fumigants. Solutions of acrylonitrile in carbon tetrachloride for soil and grain fumigants have provided a small but steady market for the past several years; however, commercially successful insecticides have not been developed using acrylonitrile derivatives.

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Key Words for Indexing

Acetylene
Acrylic Compounds
Acrylonitrile
Acrylonitrile-Butadiene-Styrene Plastics
Ammonia
Catalysts
Condensation
Copolymers
Copper Chloride
Cyanides
Elastomers
Ethylation
Ethylene Cyanohydrin
Ethylene Oxide
Fibers
Fumigants
Halogenated Hydrocarbons
Hydration
Hydrogen Cyanide
Hydrogenation
Hydrolysis
Lactonitrile
Nitriles
Oxygen
Plastics
Polymers
Polymerization
Propylene
Reactions
Rubber
Solvents
Vinyl Compounds

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Pressure vessels . . .

ASME Head Design Simplified Using Influence Coefficients

Empirical code rules predict low stresses in standard ASME heads. Galletly's method supplements rules and gives realistic stress values. Simplified charts cut week-long calculations to matters of hours

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Recent studies show that formulas for designing vessel heads, given in the ASME Unfired Pressure Vessel Code,[1] predict low stresses under certain conditions of vessel geometry and pressure. These investigations of stresses in pressure vessels,[2,9] calculated with the aid of electronic computers, have made possible the solution of the basic differential equations of the bending theory for thin-walled vessels under internal pressure over a wide range of shell and head geometric parameters.

Although the code recognizes the existence of high localized bending stresses in vessels, no design criteria is presented to compute the value of such stresses. The calculation of the bending stresses at the cylinder-head junction has been a complex and lengthy procedure which is too often ignored by the vessel designer.

With an increased use of expensive metals, and the importance for better prediction of safe operating levels, the vessel designer needs a rapid and practical method to optimize the design of pressure vessels, supplementing the present code rules in order to obtain realistic values of the stresses and the attendant safety factor incorporated in the design.

The author suggests the use of the Galletly[2] scheme of analysis for vessels with torispherical heads (standard ASME heads), and presents a series of charts of "influence coefficients" to simplify their application. The necessity for improvement in vessel design has been recognized by Honigsberg and Eschenbrenner, who, in a recent paper,[12] also suggest that the vessel analysis method of Galletly be considered in the design of torispherical heads.

Edge Influence Coefficients. Galletly[3] has made available the edge influence coefficients, representing displacements and rotations due to unit value of the moment, shear, and pressure acting on the toroidal shell section of the torispherical head, for the loading conditions shown in Figure 1. These coefficients are graphically shown in Figures 4 to 13 for the range of vessel geometric parameters normally encountered in many applications using standard ASME torispherical heads. Figures 4 to 13 have been plotted from Galletly's[3] data and interpolated graphically for intermediate values of the ratio a/b to permit convenient reading of coefficients not indicated in the tabulated values. The coefficients have been assigned designations C_{11} to C_{30}, merely to simplify their use in the numerical example.

The comparable coefficients for the cylinder C_1 to C_5, and for the spherical cap C_6 to C_{10}, computed from the formulas given in reference (4), are also shown graphically in Figures 2 and 3, for convenience.

Displacement and Rotation. The total edge displacements and rotations of each component can then be readily expressed in terms of these edge influence coefficients, and the unknown values of the moments, shears, and pressure, modified to agree with the dimensional form of the coefficients.

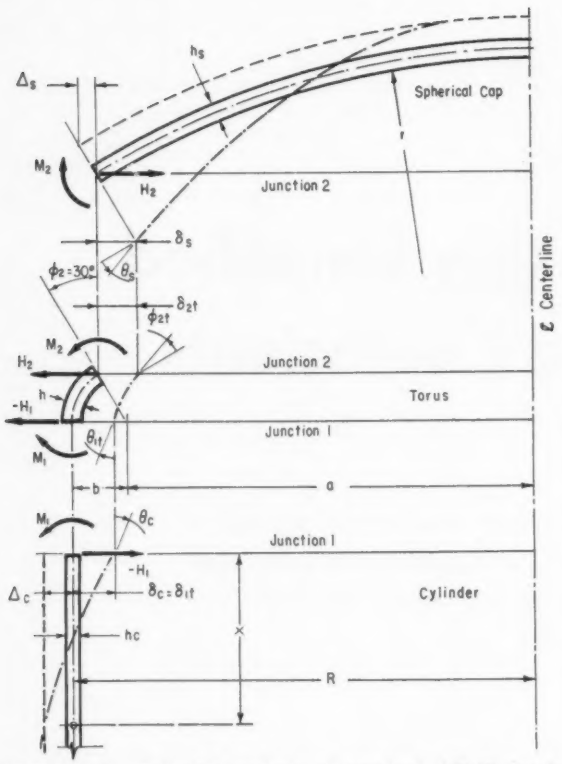

FIGURE 1—Galletly's analysis of standard ASME heads considers the relative rigidity of three components—the cylinder, the torus and the spherical cap.

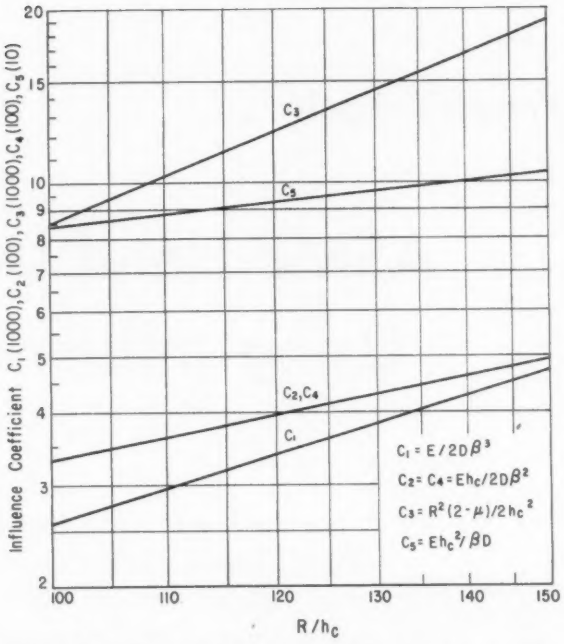

FIGURE 2—Edge influence coefficients for the cylinder.

Cylinder:

$$\delta_c = \left[C_1 H_1 + \frac{C_2}{h_c} M_1 + C_3 h_c p \right] {}^1/_E \qquad (5)$$

$$\Theta_c = \left[\frac{C_4}{h_c} H_1 + \frac{C_5}{h^2_c} M_1 \right] {}^1/_E \qquad (6)$$

Spherical Cap:

$$\delta_s = \left[C_6 H_2 + \frac{C_7}{h_s} M_2 + C_8 h_s p \right] {}^1/_E \qquad (7)$$

$$\Theta_s = \left[\frac{C_9}{h_s} H_2 + \frac{C_{10}}{h^2_s} M_2 \right] {}^1/_E \qquad (8)$$

Torus

$$\delta_{1t} = \left[C_{11} H_1 + \frac{C_{12}}{b} M_1 + C_{13} H_2 + \frac{C_{14}}{b} M_2 + C_{15} \frac{pb}{2} \right] {}^1/_E \qquad (9)$$

BACKGROUND ON THE GALLETLY METHOD

The analysis developed by Galletly considers the relative rigidity of three components, namely the cylinder, the torus, and the spherical cap, (see Figure 1) when subjected to internal pressure. It may be observed from a study of Figure 1, that each component attempts, seperately, to elastically deform under the action of the internal pressure to the positions indicated by the dashed lines. Actually, both the junctions 1 and 2 remain connected for continuity, requiring horizontal displacements δ, and rotations Θ, as shown, at an exaggerated scale in Figure 1, by the dot-dash lines. To bring each component into static equilibrium, axisymmetric edge moments, M_1 and M_2, and horizontal shears, H_1 and H_2 are applied, whose magnitude will depend on the relative stiffness of each component. The same sign convention, as used in reference (2), is adopted in Figure 1; M and H positive or negative as indicated, with δ considered positive for outward displacements, and Θ positive when the tangent rotates counterclockwise.

By equating the horizontal displacements and the rotations at each junction, the following four linear compatibility equations insure continuity of the vessel structures:

At junction 1

$$\delta_c \text{ (cylinder)} = \delta_{1t} \text{ (torus)} \qquad (1)$$

$$\Theta_c \text{ (cylinder)} = \Theta_{1t} \text{ (torus)} \qquad (2)$$

At junction 2

$$\delta_{2t} \text{ (torus)} = \delta_s \text{ (spherical cap)} \qquad (3)$$

$$\Theta_{2t} \text{ (torus)} = \Theta_s \text{ (spherical cap)} \qquad (4)$$

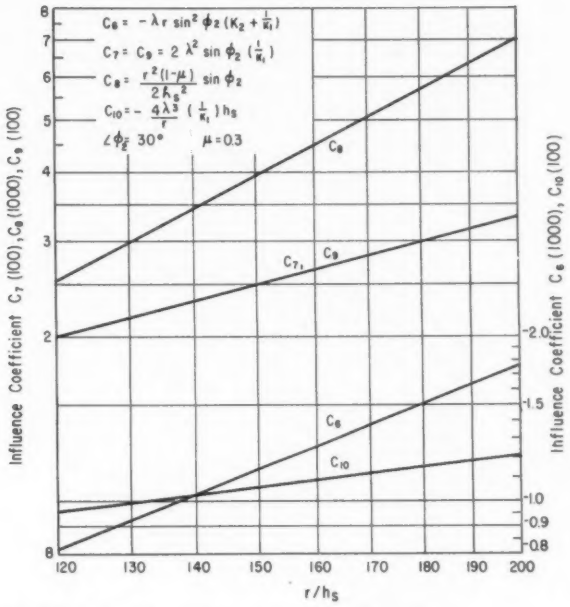
$C_8 = -\lambda r \sin^2 \phi_2 (K_2 + \frac{1}{K_1})$
$C_7 = C_9 = 2\lambda^2 \sin \phi_2 (\frac{1}{K_1})$
$C_8 = \frac{r^2(1-\mu)}{2h_s^2} \sin \phi_2$
$C_{10} = -\frac{4\lambda^3}{r} (\frac{1}{K_1}) h_s$
$\angle \phi_2 = 30°$ $\mu = 0.3$
Influence Coefficient C_7 (100), C_9 (1000), C_8 (100)
Influence Coefficient C_8 (1000), C_{10} (100)
r/h_s

FIGURE 3—Edge influence for the spherical cap.

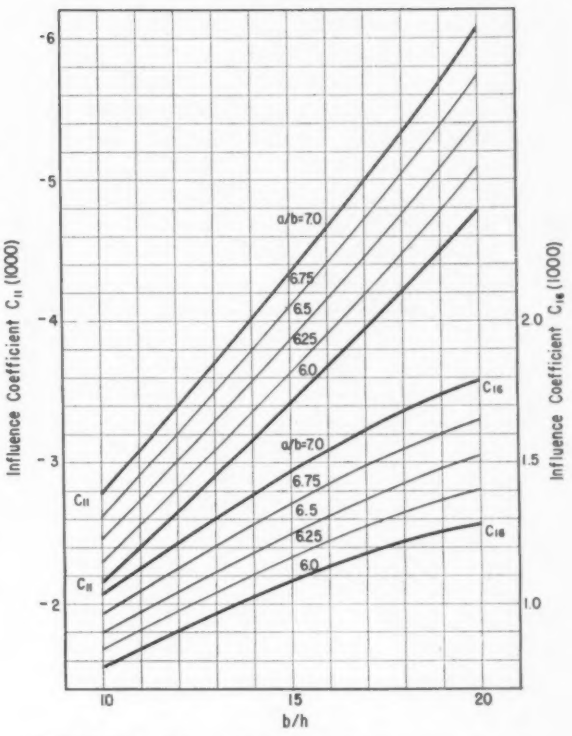

FIGURE 4—Edge influence coefficients for the torus.

$$\delta_{2t} = \left[C_{16} H_1 + \frac{C_{17}}{b} M_1 + C_{18} H_2 + \frac{C_{19}}{b} M_2 + C_{20} \frac{pb}{2} \right] {}^1/_E \quad (10)$$

$$\theta_{1t} = \left[\frac{C_{21}}{b} H_1 + \frac{C_{22}}{b^2} M_1 + \frac{C_{23}}{b} H_2 + \frac{C_{24}}{b^2} M_2 + C_{25} \frac{pb}{2} \right] {}^1/_E \quad (11)$$

$$\theta_{2t} = \left[\frac{C_{26}}{b} H_1 + \frac{C_{27}}{b^2} M_1 + \frac{C_{28}}{b} H_2 + \frac{C_{29}}{b^2} M_2 + C_{30} \frac{pb}{2} \right] {}^1/_E \quad (12)$$

Substitution of equations 5 through 12 into equations 1 through 4 will give directly the necessary compatibility equations, whose solution, as simultaneous linear equations, determines the bending moments at junction 1 and 2. With the values of the bending moments M_1 and M_2 and the shears H_1 and H_2, the stress distribu-

TABLE 1—Cylinder Functions

Location X	ψ	θ	ϕ	ζ
0	1.0	1.0	1.0	0
$\frac{\pi}{4\beta}$	0	0.322	0.644	0.322
$\frac{\pi}{2\beta}$	—0.208	0	0.208	0.208
$\frac{3\pi}{4\beta}$	—0.134	—0.067	0	0.067
$\frac{\pi}{\beta}$	—0.043	—0.043	—0.043	0

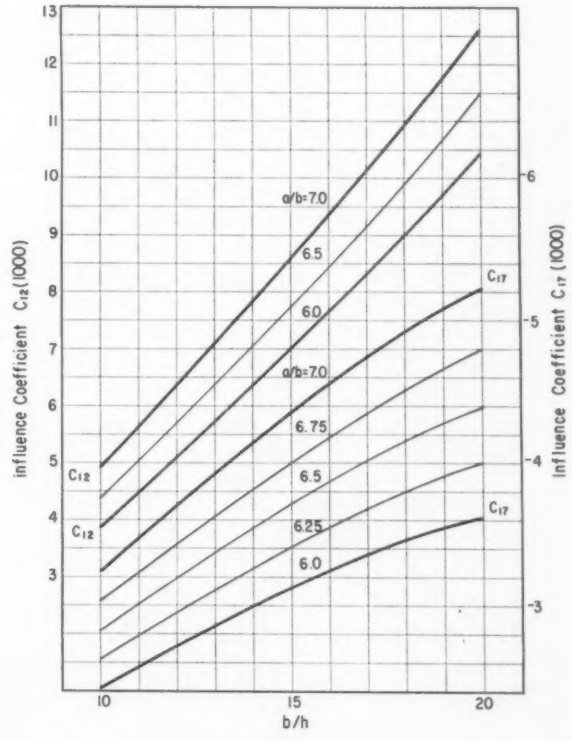

FIGURE 5

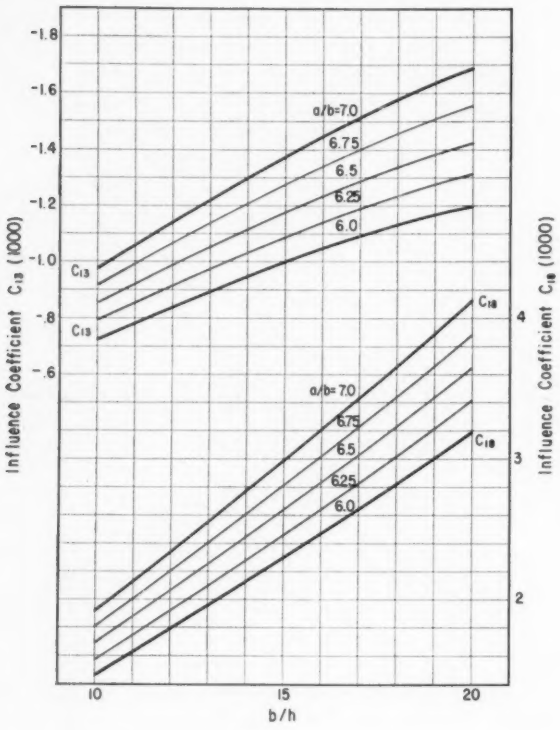

FIGURE 6

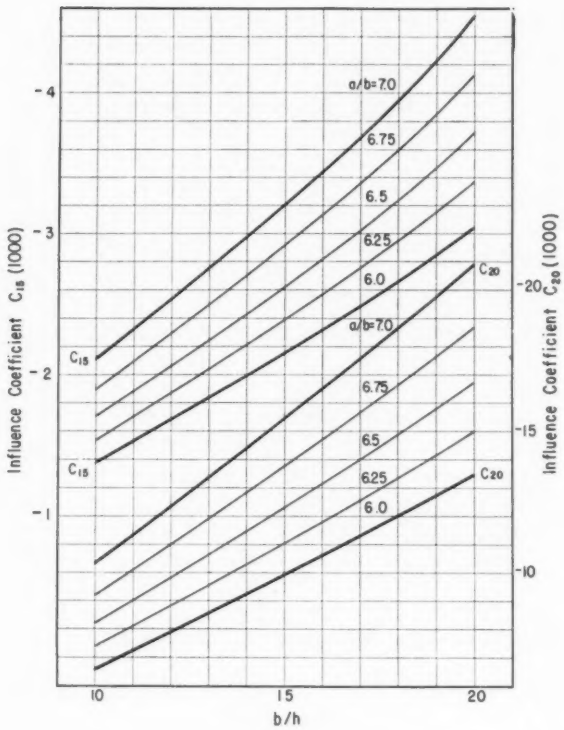

FIGURE 8

(Note: Figures 5-13 all contain edge influence coefficients for the torus)

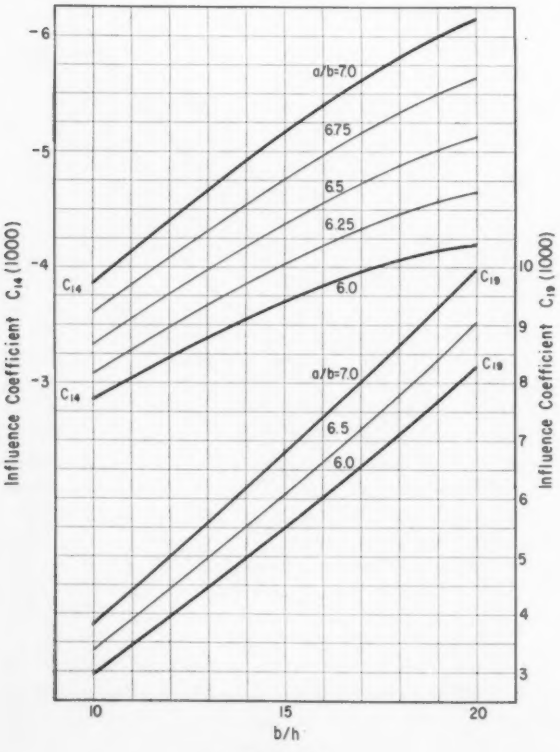

FIGURE 7

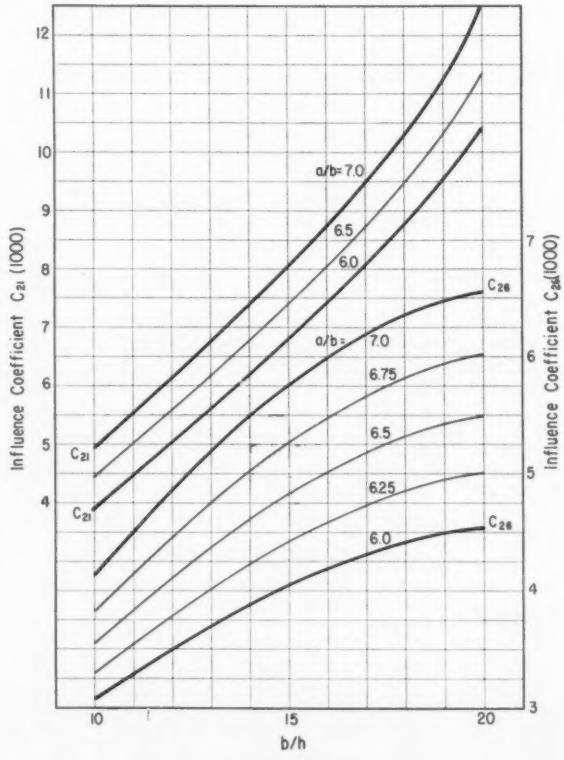

FIGURE 9

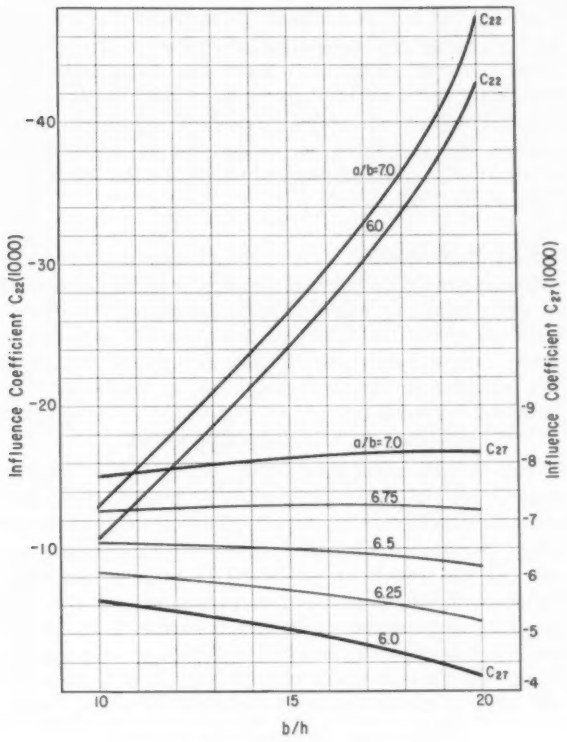

FIGURE 10

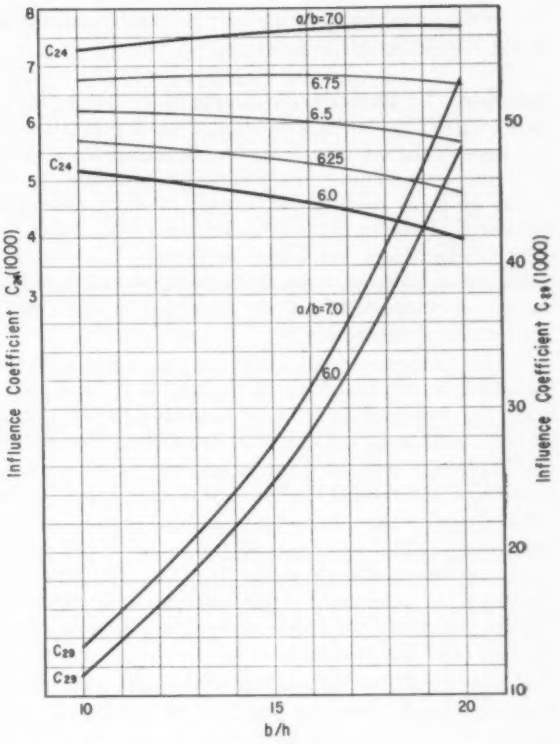

FIGURE 12

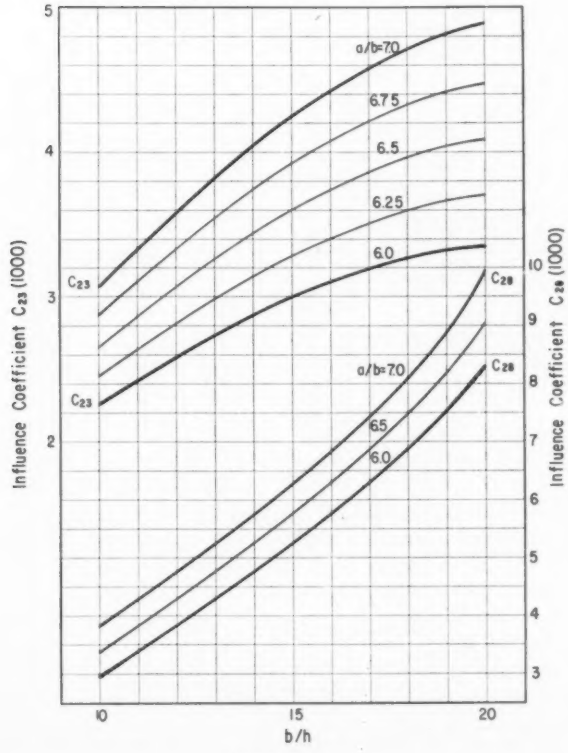

FIGURE 11

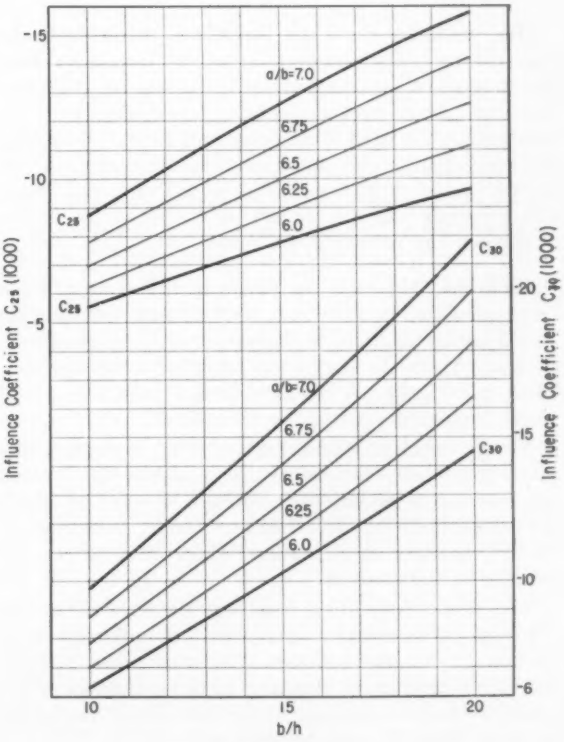

FIGURE 13

tion in the vessel components may be readily calculated by the conventional formulas.

Example. To illustrate the simplicity of using "influence coefficients" in vessel design, a numerical example is presented based on a vessel with a standard 12-ft. diameter torispherical heads having an inside corner radius of torus equal to 6 percent of head diameter. Section A of the example gives the dimensional parameters of the vessel, for each component, namely, cylinder, torus, and cap, with their thickness calculated in accord with the ASME Code formulas for the conditions outlined in Section B.

The "influence coefficients" are then obtained from Figures 2 to 13, based on the values, R/h_c, b/h, a/b, and r/h_s indicated in Section A. Although the values of the coefficients can only be read from the curves within 2 to 3 percent of accuracy, the result may be considered satisfactory for most practical applications.

To simplify the numerical work in setting up the four compatibility equations of 1 through 4, all coefficients of the collected terms H_1, M_1, H_2, M_2, are combined in appropriate dimensional form used by Galletly[3] and assigned designations a_{11} to a_{45} under Section D of the example.

Having substituted the values of the edge coefficients from Section C into the relations of Section D, the compatibility coefficients may then be entered directly in Section E, to complete the compatibility equations. The solution of these four linear equations by any of the algebriac methods yields the values of the bending moments, and shears entered under Section F.

How to Solve the Four Equations. Solution of the four compatibility linear equations by the single division scheme of Gauss's method is suitable for such calculations. Each equation should be equated to 0 by transposing the right hand term, and then, substituting the coefficients, with due regard to their sign, in the scheme outlined in Table 2. The use of a calculator will generally expedite results, in obtaining the values of the bending moments and shears.

Accuracy. Although the values in the example have been calculated by slide rule, with all numbers rounded and decimals omitted, to demonstrate the method, references (5) to (8) may be of interest to the designer, when investigating a range of design parameters, and where improved accuracy is warranted.

The calculations under Section G of the actual displacement and rotations of the components at each junction, using equations 5 through 8 serve to check the magnitude of deformation. Large deformations involve changes in curvature which may affect the validity of the analysis.

The stress distribution may then be obtained by the conventional formulas (Reference 4) as indicated under Section H, for the cylinder. The total stress includes the effect of internal pressure, p, the deflection of the cylinder, and the bending at the junction 1 due to the imposed shear H, and bending moment M. For convenience, the cylinder functions, ψ, Θ, ϕ, ζ, are indicated in Table 1 as compiled from Table 45 of Reference (4). By first computing the value of β (refer to nomenclature for formula) and using the values of H_1 and M_1 from Section F, both the circumferential and longitudinal stresses may be readily determined. These stresses are computed at various points X measured along the cylinder primarily to indicate the stress pattern at this junction 1.

Stress Distribution. The calculation of the stress distribution in the cylinder of the vessel under Section H of the example reveals that both the maximum circumferential stress (—20,480 psi compressive) and maximum longitudinal stress (28,580 psi tensile) occurs at the junction of the shell and head. In particular, the longitudinal stress exceeds the allowable working stress (15,000 psi) by approximately 90 percent.

The ASME code does not as yet offer any specific criteria for the allowable stresses at torispherical head cylinder junction. A reasonable limit for this stress, to avoid permanent deformations at the operating pressure of the vessel would be 90 percent of the yield strength of the material of construction. For the material of the example, with a yield strength of 32,000 psi, the allowable design stress is 29,800 psi. The maximum longitudinal stress (28,580 psi), although below the value of the design stress, indicates the safety factor,

TABLE 2—Solution for Four Linear Compatibility Equations

Line	a_{11}	a_{12}	a_{13}	a_{14}	a_{15}
1	a_{21}	a_{22}	a_{23}	a_{24}	a_{25}
2	$m_1 = \frac{a_{21}}{a_{11}}$	$m_1 \cdot a_{12}$	$m_1 \cdot a_{13}$	$m_1 \cdot a_{14}$	$m_1 \cdot a_{15}$
3	a_{31}	a_{32}	a_{33}	a_{34}	a_{35}
4	$m_2 = \frac{a_{31}}{a_{11}}$	$m_2 \cdot a_{12}$	$m_2 \cdot a_{13}$	$m_2 \cdot a_{14}$	$m_2 \cdot a_{15}$
5	a_{41}	a_{42}	a_{43}	a_{44}	a_{45}
6	$m_3 = \frac{a_{41}}{a_{11}}$	$m_3 \cdot a_{12}$	$m_3 \cdot a_{13}$	$m_3 \cdot a_{14}$	$m_3 \cdot a_{15}$
	Subtract Line 2 from 1	a'_{22}	a'_{23}	a'_{24}	a'_{25}
7	Subtract Line 4 from 3	a'_{32}	a'_{33}	a'_{34}	a'_{35}
8		$m_4 = \frac{a'_{32}}{a'_{22}}$	$m_4 \cdot a'_{23}$	$m_4 \cdot a'_{24}$	$m_4 \cdot a'_{25}$
9	Subtract Line 6 from 5	a'_{42}	a'_{43}	a'_{44}	a'_{45}
10		$m_5 = \frac{a'_{42}}{a'_{22}}$	$m_5 \cdot a'_{23}$	$m_5 \cdot a'_{24}$	$m_5 \cdot a'_{25}$
		Subtract Line 8 from 7	a''_{33}	a''_{34}	a''_{35}
11		Subtract Line 10 from 9	a''_{43}	a''_{44}	a''_{45}
12			$m_6 = \frac{a''_{43}}{a''_{33}}$	$m_6 \cdot a''_{34}$	$m_6 \cdot a''_{35}$
			Subtract Line 12 from 11	a'''_{44}	a'''_{45}

$$M_2 = -\frac{a'''_{45}}{a'''_{44}}$$

$$H_2 = -\frac{a''_{35} + (a''_{34} \cdot M_2)}{a''_{33}}$$

$$M_1 = -\frac{a'_{25} + (a'_{24} \cdot M_2) + (a'_{23} \cdot H_2)}{a'_{22}}$$

$$H_1 = -\frac{a_{15} + (a_{14} \cdot M_2) + (a_{13} \cdot H_2) + (a_{12} \cdot M_1)}{a_{11}}$$

EXAMPLE 1

A. Geometric Characteristics—Fig. 1

Cylinder	Torus	Cap
$R = 71.3$ $h_c = 0.5$ $R/h_c = 142.6$	$a = 62.4$ $\quad h = .813$ $b = 9.16$ $\quad b/h = 11.3$ $a/b = 6.8$ $\quad \phi_2 = 30°$	$r = 132.4$ $h_c = 0.813'$ $r/h_c = 163$

B. Material and Design Conditions

Material Spec.—SA 201 GR-B
Internal Pressure = 100 PSI at 250° F
Weld Joint Efficiency = $E_j = 1$
Allow. Working Stress = $SE_j = 15000$ PSI
Modulus of Elasticity = $E = 30 \times 10^6$

C. Edge Coefficients

Cylinder Fig. 2	Cap—Fig. 3	Torus Fig. 4 To Fig. 13			
$C_1 = 4300$	$C_6 = -1300$	$C_{11} = -3030$	$C_{16} = 1100$	$C_{21} = 5600$	$C_{26} = 4300$
$C_2 = 470$	$C_7 = 270$	$C_{12} = -5600$	$C_{17} = -3350$	$C_{22} = -16000$	$C_{27} = -7300$
$C_3 = 17300$	$C_8 = 4700$	$C_{13} = -1030$	$C_{18} = 2100$	$C_{23} = 3200$	$C_{28} = 4350$
$C_4 = 470$	$C_9 = 270$	$C_{14} = -4000$	$C_{19} = 4350$	$C_{24} = 6900$	$C_{29} = 16200$
$C_5 = 102$	$C_{10} = -110$	$C_{15} = -2200$	$C_{20} = -10700$	$C_{25} = -9000$	$C_{30} = -10300$

D. Compatibility Equation Coef.

$a_{11} = C_1 - C_{11} = 7330$	$a_{12} = \frac{C_2}{h_c} - \frac{C_{12}}{b} = 328$	$a_{13} = C_{13} = -1030$	$a_{14} = C_{14}/b = -437$	$a_{15} = \frac{C_{15}b}{2} - C_3h_c = -18720$
$a_{21} = \frac{C_4}{h_c} - \frac{C_{21}}{b} = 328$	$a_{22} = \frac{C_5}{h_c^2} - \frac{C_{22}}{b^2} = 598$	$a_{23} = C_{23}/b = 349$	$a_{24} = C_{24}/b^2 = 82$	$a_{25} = C_{25}/2 = -4500$
$a_{31} = C_{16} = 1100$	$a_{32} = C_{17}/b = -366$	$a_{33} = C_6 - C_{18} = -3400$	$a_{34} = \frac{C_7}{h_c} - \frac{C_{19}}{b} = -143$	$a_{35} = \frac{C_{20}b}{2} - C_8h_c = -52820$
$a_{41} = C_{26}/b = 470$	$a_{42} = C_{27}b^2 = -87$	$a_{43} = \frac{C_9}{h_c} - \frac{C_{28}}{b} = -143$	$a_{44} = \frac{C_{10}}{h_c^2} - \frac{C_{29}}{b^2} = -359$	$a_{45} = C_{30}/2 = -5150$

E. Compatibility Equations

$\delta_{11} = \delta_c$	$a_{11}H_1 + a_{12}M_1 - a_{13}H_2 - a_{14}M_2$ $7330H_1 + 328M_1 + 1030H_2 + 437M_2$	$= a_{15}P$ $= -1872{,}000$
$\theta_{11} = \theta_c$	$a_{21}H_1 + a_{22}M_1 - a_{23}H_2 - a_{24}M_2$ $328H_1 + 598M_1 - 349H_2 - 82M_2$	$= a_{25}P$ $= -450{,}000$
$\delta_{21} = \delta_s$	$-a_{31}H_1 - a_{32}M_1 + a_{33}H_2 + a_{34}M_2$ $-1100H_1 + 366M_1 - 3400H_2 - 143M_2$	$= a_{35}P$ $= -5282{,}000$
$\theta_{21} = \theta_s$	$-a_{41}H_1 - a_{42}M_1 + a_{43}H_2 + a_{44}M_2$ $-470H_1 + 87M_1 - 143H_2 - 359M_2$	$= a_{45}P$ $= -515{,}000$

F. Bending Moments and Shears.

$H_1 = -654$
$M_1 = 894$
$H_2 = 1788$
$M_2 = 1797$

G. Displacements and Rotations At Junction 1 and 2

$\delta_c = [C_1H_1 + (C_2/h_c)M_1 + C_3h_cP]\,1/E = -0.037$
$\delta_s = [C_6H_2 + (C_7/h_c)M_2 + C_8h_cP]\,1/E = -0.045$

$\theta_c = [(C_4/h_c)H_1 + (C_5/h_c^2)M_1]\,1/E = -0.0083$
$\theta_s = [(C_9/h_c)H_2 + (C_{10}/h_c^2)M_2]\,1/E = 0.0098$

H. Stress Distribution In Cylinder

	Location Measured From Junction		X = 0	X = π/4β	X = π/2β	X = 3π/4β	X = π/β
Circumferential Stress	Due to Pressure	$\varsigma_y = PR/h_c$	14260	14260	14260	14260	14260
	Due to Deflection	$\varsigma_y = \frac{2R\beta}{h_c}(\beta M_1\phi_1 + H_1\theta)$	−28300	−12900	− 2450	1110	1220
	Due to Bending	$\varsigma_y = \pm\frac{6\mu}{\beta h_c^2}(\beta M_1\phi + H_1\zeta)$	± 6440	± 2900	± 3220	± 1400	± 280
	Total Stress	ς_y Outside Shell	− 7600	4260	15030	16770	15760
		ς_y Inside Shell	−20480	− 1540	8590	13970	15200
Longitudinal Stress	Due to Pressure	$\varsigma_x = PR/2h_c$	7130	7130	7130	7130	7130
	Due to Bending	$\varsigma_x = \pm\frac{6}{\beta h_c^2}(\beta M_1\phi + H_1\zeta)$	±21450	± 9670	± 10720	± 4670	± 930
	Total Stress	ς_x Outside Shell	28580	16800	17850	11800	8060
		ς_x Inside Shell	−14320	− 2540	− 3590	2460	6200

at the head-cylinder junction, has decreased to 2.1 from the code required value of 4.

The presence of any other imposed loads, besides the internal pressure of the vessel, can readily stress the area beyond the desired limit. The vessel designer should therefore be cognizant of the value in applying an advanced scheme of analysis, as outlined by the example, and made practical by the voluminous data of Galletly,[2] which has contributed to the knowledge in this important field of vessel design.

Ellipsoidal Heads. From recent analytical work on stresses in vessels with ellipsoidal heads, Kraus, Bilodeau and Langer[9] have compiled very useful design data for a wide range of geometric parameters. The data include stresses in ellipsoidal heads, having a ratio of major to minor axis of 3, which approach the dimensional contour of standard ASME torispherical heads. It serves as a useful guide in estimating the location of the maximum stresses for torispherical heads, although such heads do not duplicate exactly the configuration of ellipsoidal heads.

The results of their investigations reveal very interesting agreements, not only with the experimental work of Cooper, Smith, et al,[10] and Fessler and Rose,[11] but also show excellent agreement with Galletly's method.

For a h/h_c ratio of 1.77 (and R/h_c not greater than 150) corresponding to the ratio normally encountered in most ASME designs with torispherical heads, the maximum stress occurs in the cylinder section of the junction, and specifically, the longitudinal stresses on the inside of the cylinder. However, as the head-cylinder thickness ratio approaches 1.0, the maximum stress occurs in the torus section. Generally, torispherical heads are manufactured with a straight cylindrical flange section, which shifts the head-cylinder junction from the torus. This straight flange tends to stiffen the head-cylinder junction, increasing the stress in the torus section, but reducing the magnitude of the stresses in cylinder section. The use of torispherical heads with maximum length straight flange is desirable, since the stress conditions are considerably improved at the circumferential weld joint. Further improvement in the stress condition of each component of the torispherical head-cylinder sections may be expected by increasing the inside radius of torus from 6 percent of the head diameter to 9 percent. Such heads approach the configuration of an ellipsoidal head with major to minor axis ratio of 2:5. The standard 2:1 ellipsoidal head becomes the logical choice if the stress levels in the torispherical heads are unsuited for design conditions.

The stress calculations, although limited in the numerical example 1, to the stress distribution at the cylinder-head junction, may be extended to the torus section by the use of Galletly's interior influence coefficients of the stress resultants. Such data, too voluminous for publication, is, however, available at the Engineering Societies Library in New York.

NOMENCLATURE

(Refer also to Figure 1)

R = Mean raduis of cylinder, in.
r = Mean radius of spherical cap, in.
h_c = Cylinder thickness, in.
h = Torus thickness, in.
h_s = Spherical cap thickness, in.
a = R - b, in.
b = Mean radius of torus, in.
Φ_2 = 90° - (Angle subtended by torus)
δ_c = Horizontal displacement of cylinder, in.
δ_{1t} = Horizontal displacement of torus at junction 1, in.
δ_{2t} = Horizontal displacement of torus at junction 2, in.
δ_s = Horizontal displacement of spherical cap, in.
Θ_c = Rotation of cylinder at edge of junction 1.
Θ_{1t} = Rotation of torus at junction 1.
Θ_{2t} = Rotation of torus at junction 2.
Θ_s = Rotation of spherical cap at junction 2.
Δ_c = Horizontal displacement of cylinder, due to pressure only.
Δ_s = Horizontal displacement of spherical cap, due to pressure only.
p = Internal pressure, psi.
$C_1 \ldots C_5$ = Cylinder edge influence coefficients.
$C_6 \ldots C_{10}$ = Spherical cap edge influence coefficients.
$C_{11} \ldots C_{30}$ = Torus edge influence coefficients.
$a_{11} \ldots a_{45}$ = Compatibility equation coefficients.
H_1 = Horizontal shear at junction 1, lbs./in.
M_1 = Bending moment at junction 1, in.-lb./in.
H_2 = Horizontal shear at junction 2, lbs./in.
M_2 = Bending moment at junction 2, in.-lb./in.
μ = Poisson's ratio.
E = Young's modulus, psi.
$\beta = [3(1 - \mu^2)/R^2 h_c^2]^{1/4}$
Ψ = Cylinder function, $\Theta - \zeta$
Θ = Cylinder function, $e^{-\beta x} \cos \beta X$
Φ = Cylinder function, $\Theta + \zeta$
ζ = Cylinder function, $e^{-\beta x} \sin \beta X$
χ = Axial distance from head-cylinder junction to a general point on cylinder, in.
SE_j = Allowable working stress multiplied by joint efficiency of weld.
E_j = Weld joint efficiency.
σ_x = Longitudinal stress in cylinder, psi.
σ_y = Circumferential stress in Cylinder, psi.
$D = E h^3/12(1 - \mu^2)$
$\lambda = [3(1 - \mu^2)\ (r/h_s)^2]^{1/4}$

$$K_1 = 1 - \frac{1 - 2\mu}{2\lambda} \cot \Phi_2$$

$$K_2 = 1 - \frac{1 + 2\mu}{2\lambda} \cot \Phi_2$$

About the Author

Raymond R. Maccary is the project engineering manager for Mallet & Company, Inc., Pittsburgh, where he is in charge of the overall direction of process plant design, engineering, construction, operational startups and maintenance procedures. Mr. Maccary holds a B.S. degree in mechanical engineering from Cooper Union Institute of Technology and has done graduate work at New York University. He has had many years of engineering design experience having been associated with such firms as Griscom-Russell, the M. W. Kellogg Company, the Kellex Corp., H. K. Porter Company and as president of Process Industries Engineers, Inc., before assuming his present position.

Maccary

Key Words for Indexing

Codes | Ellipsoidal | Stresses
Coefficients | Pressure Vessels | Torispherical

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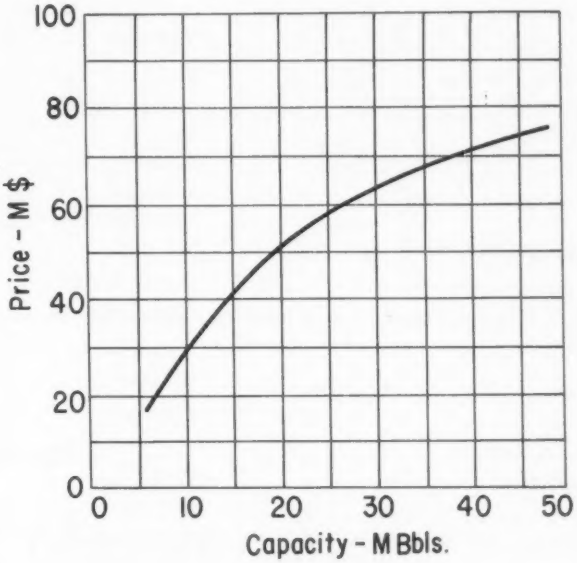
Equipment Cost Data File

HEMISPHEROIDS

N. H. Prater, Mobay Chemical Co., Pittsburgh, Pa.
John Mylo, The Chemstrand Corp., Decatur, Ala.

Hemispheroids with cylindrical shells and smooth roofs and bottoms are called plain hemispheroids. The entire capacity is included between the levels of the bottom and top of the cylindrical shells. This design usually requires more steel than for the spheroid tank, but the cost of fabricating and erecting the cylindrical shell is less, resulting in a lower total cost.

Basic hemispheroid tank costs can be estimated from this chart. Included in these costs are the following accessories: Manholes, spiral stairway, gaging and sampling devices, relief valves and flanged connections for the usual appurtenances. All prices are for delivered and erected tanks on customer's foundation.

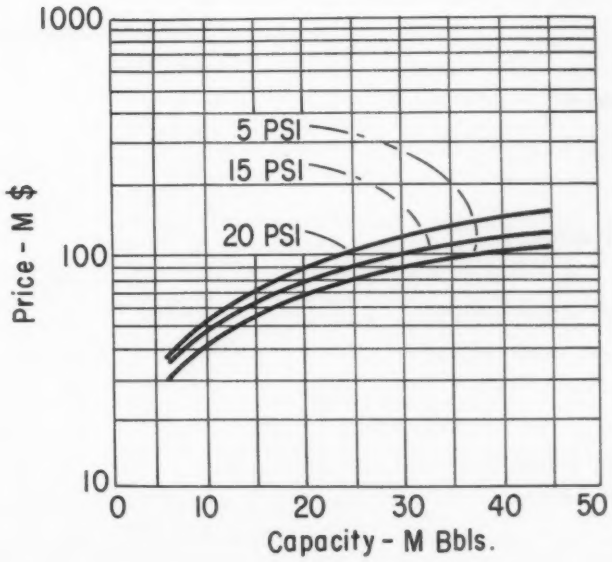


Equipment Cost Data File

SPHEROIDS

Plain spheroid tanks are usually employed for working pressures between 10 and 30 pounds per square inch for storage capacities up to 40,000 barrels. For storage capacities above this level, noded spheroids are used.

The cost of spheroid storage tanks delivered and erected on customer's foundation can be obtained from this chart. These tanks are designed to rest on prepared grades shaped to fit the contour of the tank bottom. Standard accessories included in the purchased cost are manholes, relief valves, gaging and sampling devices, spiral stairways, handrails and flanged connections for the usual appurtances.



HEMISPHEROIDS

The costs for low pressure hemispheroid storage tanks are from firm vendor quotations. Plain hemispheroid tanks are used for storage pressures of 2½ pounds per square inch in capacities up to and including 30,000 barrels. Noded hemispheroid tanks are commonly employed for capacity ranges from 20,000 through 40,000 barrels. Above this capacity level, noded spheroid designs are used. Current prices for these tanks can be maintained by taking bids from time-to-time and correcting prices accordingly.

Date:	3-20-60	3-20-60	3-20-60
M/S Index:	237	237	237
Capacity:	10,000 Barrels	20,000 Barrels	30,000 Barrels
Size:	42′ ϕ 40′ High	60′ ϕ 40′ High	67′ ϕ 48′ High
Type:	Vertical Cylindrical	Vertical Cylindrical	Vertical Cylindrical
Tank Pressure:	2.5 PSI	2.5 PSI	2.5 PSI
Type of Roof:	Hemispheroid	Hemispheroid	Noded Hemispheroid
Material of Construction:	Carbon Steel	Carbon Steel	Carbon Steel
Weight:	.....	.....	.....
Price:	$29,000	$52,000	$63,000
F.O.B.:	Florida	Florida	Florida
Price Per Pound:	.....	.....	.....
Price Per Barrel:	$2.90	$2.60	$2.10
Code:	API 620	API 620	API 620

SPHEROIDS

Plain spheroid tanks as originally conceived, consist of a steel shell built to an ideal shape although the shape is modified slightly for commercial applications. An outside ring girder and a series of brackets support the overhanging load on the shell when the pressure on the inside of the tank is less than the maximum design pressure. However, no inside framing is employed. Spheroids with a design pressure of 15 pounds per square inch or lower are designed to meet API standard 620. Above this pressure plain spheroids are normally used and are designed to meet the ASME and API-ASME codes for unfired pressure vessels. The costs for this type intermediate pressure storage tank were obtained from firm vendor quotations.

Date:	3-20-60	3-20-60	3-20-60
M/S Index:	237	237	237
Capacity:	10,000	20,000	40,000
Size:	52′ ϕ 34′ High	67′ ϕ 41′ High	85′ ϕ 51′ High
Tank Pressure:	5 PSI	15 PSI	20 PSI
Type:	Spheroid	Spheroid	Spheroid
Material of Construction:	Carbon Steel	Carbon Steel	Carbon Steel
Weight:	.....	.....	.....
Price:	$41,000	$76,000	$159,000
F.O.B.:	Florida	Florida	Florida
Price Per Pound	.....	.....	.....
Price Per Barrel:	$4.10	$3.80	$3.97
Code:	API 620	API 620	ASME

REPAIR ORDER COST REPORT (FOR FOREMEN)

R. O. NUMBER	DATE	COST CODE	EQUIP. GROUP	TYPE CODES	WORK GROUP	ESTIMATED COST LABOR	ESTIMATED COST MAT'L.	ESTIMATED COST TOTAL	CURRENT COST LABOR	CURRENT COST MAT'L.	CURRENT COST TOTAL	COST TO DATE LABOR	COST TO DATE MAT'L.	COST TO DATE TOTAL	BACKLOG HOURS	O'TIME HOURS	%
C3165	COMPRESSOR O.	H.			1112			5									
	9-26	30C	6	D1	1113	1400	400	1800	180	70	250	600	200	800	185		45
					TOTAL	1400	400	1800	180	70	250	600	200	800	185		
C3166	REPR FURNACE	ARCHES			1112			5									
	9-26	21C	2	D1	1112	200	50	250	70		70	150	50	200	11	8	
					1774	700	250	950	530	200	730	650	250	900	11	16	
					TOTAL	900	300	1200	600	200	800	800	300	1100	22	24	90
C3181	REPAIR PUMP				1112			3									
	9-26	21C	7	D2	1112	140	60	200	140	30	170	140	130	270			
					4101	60	140	200	110	120	230	110	220	330	-11		
					TOTAL	200	200	400	250	150	400	250	350	600	-11		150X
C3296	TRAVELING SCREENS				1112			3									
	9-26	30C	7	I1	1112	300	50	350	140	60	200	140	60	200	14		
					TOTAL	300	50	350	140	60	200	140	60	200	14		57

	THIS WKS CHARGES ($) LABOR	MATL	TOTAL	BACKLOG (HRS) DIR	IND	TOTAL	OVERTIME (HRS) DIR	IND	TOTAL
1112	530	160	690	196	14	210	8		8
1774	530	200	730	11		11	16		16
4101	110	120	230	-11		-11			
TOTAL	1170	480	1650	196	14	210	24		24

FIGURE 1—The foreman's report is the basic instrument in the system.

Let your computer compile...

Reports for Maintenance Cost Control

Don't worry about what you need to tell the computer, develop the report you want and get a data-processing programer to solve the problem

E. A. Rachal and W. E. Dougher
E. I. du Pont de Nemours & Co., Aiken, S.C.

The trend to automation in processing plants has greatly increased maintenance costs. Management has developed a high interest in the control of these costs because of their effect on over-all product cost. Du Pont decided that because the computer represents the most modern method for compiling data, it would be a very valuable tool for maintenance cost analysis.

Instead of being restricted by what the machines could or could not do, we developed the reports that we wanted and then asked skilled electronic data-processing programers to solve the problem of how to get them.

How the System Works. Field data (from work orders, time sheets, purchase orders, and the like) are entered into the data-processing equipment, and the output from the equipment is tabulated on a series of reports, each tailored to meet the needs of a particular individual.

The reports fall in three main categories: the Repair Order Cost Report, the Maintenance Expenditures Reports, and the Personnel Distribution Report. The Maintenance Expenditures category includes four types of reports, giving a total of six different kinds of reports which make up the system.

Repair Order Cost Report (Figure 1). This report is the basic control instrument in the system. It is issued directly to the foreman to assist in the control of the individual jobs assigned to him. The report is provided weekly on all repair orders which were charged-to during the week, and monthly on all open orders, regardless of activity. Each foreman receives a report only on those orders assigned to him for execution.

This report places upon the foreman both the administrative responsibility and the wherewithal to control the cost of work assigned to him. In concise and readable form it shows him:

1. The labor and material cost estimated and authorized for each work group under each repair order.

2. The labor and material cost generated during the report week under each repair order, and by whom.
3. The total labor and material cost generated to date under each repair order, and by whom.
4. Backlog; that is, the number of man-hours authorized but unexpended, for each work group under each repair order.
5. Overtime hours worked under each repair order, and by which work group.

Finally, the labor and material charges made by each work group during the report week are totaled, as are the group's backlog and overtime hours, with a breakdown into direct work (i.e., regular maintenance) and indirect work (i.e., new construction and design changes).

Maintenance Expenditures Report. Next we have four reports that share the same basic title—Maintenance Expenditures Report. All four reports are printed on the same form, but they differ considerably in the amount of detail they contain.

Maintenance Expenditures—Cost Code Detail. This report is issued monthly to the area supervisor to meet both his interest in the expenses of the individual jobs assigned to his foremen, and his administrative interest in the cost of maintaining the equipment in his area. For these reasons, this report was designed to provide a summary of expenses by functional cost code and by the type of equipment under each cost code, with a listing of the individual repair orders involved. Should further detail be required on any specific job cost, the supervisor has immediate access to the foreman's Repair Order Cost Report.

The specific information given in the report is as follows:

1. Labor costs, material costs, and total costs for the month are given for each equipment group under each cost code. These costs are further classified as direct or indirect maintenance. The cost contributed by each repair order is also given.
2. For comparison, the average monthly cost is given for the last three months and for the last 12 months.
3. The percent of the cost attributable to direct maintenance is shown, as is the percent of cost attributable to expenditures for labor only.

Maintenance Expenditures—Composite Cost Code Detail. This report is issued monthly to each facility custodian (Editor's Note: Also called equipment owner, operator, etc. in other companies) and is identical to the area supervisor's report except that it includes the expenditures of all four Works Engineering Departments (Maintenance, Instrument, Electrical, Transportation) rather than just one of them. Thus, the facility custodian is kept informed as to all maintenance costs that have been charged to the cost codes for which he is responsible.

Maintenance Expenditures—Cost Code Summary. This report provides higher supervision in each Works Engineering Department (Maintenance, Instrument, Electrical, Transportation) with a brief monthly report of the expenses incurred by the individual department during the month. It contains the same basic information as the area supervisor's report, but without subdivision into equipment groups and individual repair

MAINTENANCE EXPENDITURES REPORT (COMPOSITE COST CODE SUMMARY)

DATE MO	DATE YR	COST CODE	EQUIP GROUP	COST SOURCE / DETAIL CODE		DIRECT MAINTENANCE LABOR	DIRECT MAINTENANCE MAT'L	DIRECT MAINTENANCE TOTAL	INDIRECT MAINTENANCE LABOR	INDIRECT MAINTENANCE MAT'L	INDIRECT MAINTENANCE TOTAL	TOTAL COST - CURRENT MONTH LABOR	TOTAL COST - CURRENT MONTH MAT'L	TOTAL COST - CURRENT MONTH TOTAL	AVERAGE COST PER MONTH LAST 3 MOS	AVERAGE COST PER MONTH LAST 12 MOS	% DIRECT	% LABOR
C	9	8	21C		1	1200	300	1500	150	50	200	1350	350	1700	1300	1600	88	79
					2	800	200	1000	200	150	350	1000	350	1350	1300	1400	74	74
					3	600	400	1000	50	150	200	650	550	1200	1000	950	83	54
					4	400	100	500	100	50	150	500	150	650	700	750	77	77
			21C	TOTAL		3000	1000	4000	500	400	900	3500	1400	4900	4300	4700	82	71
			30C		1	500	300	800	150	50	200	650	350	1000	1200	1400	80	65
					2	300	150	450	50	20	70	350	170	520	600	750	86	67
					3	150	100	250	100	30	130	250	130	380	400	550	66	66
					4	50	50	100	130	70	200	180	120	300	250	400	33	60
			30C	TOTAL		1000	600	1600	430	170	600	1430	770	2200	2450	3100	73	65
				POWER	1	1700	600	2300	300	100	400	2000	700	2700	2500	3000	85	74
					2	1100	350	1450	250	170	420	1350	520	1870	1900	2150	78	72
					3	750	500	1250	150	180	330	900	680	1580	1400	1500	79	57
					4	450	150	600	230	120	350	680	270	950	950	1150	63	72
			TOT POWER			4000	1600	5600	930	570	1500	4930	2170	7100	6750	7800	80	70
						(NOTE: COST CODES TOTALS FOR "PROCESS" AND "OTHER" CATEGORIES ARE AS IN ABOVE "POWER" EXAMPLE:)												

DEPARTMENT CODES 1 - MAINTENANCE 2 - ELECTRICAL 3 - INSTRUMENT 4 - TRAFFIC & TRANSPORTATION

AVERAGES INCLUDE CURRENT MONTH COSTS

FIGURE 2—Management determines cost trends from this report.

PERSONNEL DISTRIBUTION REPORT

FROM REPAIR ORDER LABOR HOURS

FOR MONTH OF SEPTEMBER, 1958

AREA	WORK GROUP	REGULAR ORDERS — HOURS WORKED			EQUIVALENT EMPLOYEES	BLANKET ORDERS — HOURS WORKED				EQUIVALENT EMPLOYEES	REGULAR ORDERS — %			BLANKET ORDERS — %			
		DIRECT	INDIRECT	TOTAL		DIRECT — PERM. ASSGT.	DIRECT — MAINT. & ROUTINE	INDIRECT	TOTAL		% REG. O.O. HOURS DIRECT	% REG. O.O. HOURS INDIRECT	% TOTAL R. O. HOURS	% BLANKET O.O. HOURS DIRECT	% BLANKET O.O. HOURS INDIRECT		% TOTAL R. O. & BLANKET
F	1211	1600	1000	2600	15	800		200	1000	6	44	28	72	22		6	28
	1212	1200	500	1700	10	700			700	4	50	21	71	29			29
	SUB TOT	2800	1500	4300	25	1500		200	1700	10	47	25	72	25		3	28
	1771	600	300	900	5						67	33	100				0
	SUB TOT	600	300	900	5						67	33	100				0
F	AREA TOT	3400	1800	5200	30	1500		200	1700	10	49	26	75	22		3	25
H	1221	1800	800	2600	15	900			900	5	51	23	74	26			26
	1222	1000	700	1700	10	2600			2600	15	24	16	40	60			60
	SUB TOT	2800	1500	4300	25	3500			3500	20	36	19	55	45			45
	1771	1000	700	1700	10						60	40	100				0
	1773	900		900	5						100		100				0
	SUB TOT	1900	700	2600	15						73	28	100				0
H	AREA TOT	4700	2200	6900	40	3500			3500	20	45	21	66	34			34
	DIV TOTAL																
	AREA PER	5600	3000	8600	50	5000		200	5200	30	40	22	62	37		1	38
	717A PER	2500	1000	3500	20						76	28	100				0
	TOTAL	8100	4000	12100	70	5000		200	5200	30	47	23	70	29		1	30

FIGURE 3—This report helps evaluate manpower effectiveness.

orders under each cost code. Specifically, the report shows:

1. Labor costs, material costs, and total costs charged to each cost code during the month for direct maintenance, indirect maintenance, and both types combined.
2. The average monthly cost charged to each cost code for the last three months and for the last 12 months.
3. The percent of the cost attributable to direct maintenance, and the percent attributable to labor expenditures.

Maintenance Expenditures—Composite Cost Code Summary (Figure 2). This report is issued to management and to the superintendents of the Operating Departments, who are concerned with the cost of maintaining plant facilities rather than with the isolated expenditures of a particular Works Engineering Department. Management is interested in over-all costs, trends, and distribution. This report furnishes that information.

The report is identical to the preceding Cost Code Summary Report except that it includes the expenditures of all four Works Engineering Departments. Thus, the total monthly cost of maintaining each facility is presented (each cost code normally represents one facility), and the amount that each Works Engineering Department contributed to this total is noted.

Personnel Distribution Report (Figure 3). A separate report is issued each month summarizing personnel distribution. This is a significant part of the over-all report system, for the data provides supervision and management with the actual use of maintenance manpower. The number of mechanics used on routine maintenance, plant alterations, and preventive maintenance programs is listed, as well as the amount of assistance being provided to an assigned area work force by outside work forces. The same information is also presented in percentage form.

This data is essential for the evaluation of workload, the effective use of manpower, and the construction of budget forecasts. The report is issued monthly to area, division, and department supervisors.

Results Have Been Beneficial. The data-processing machines are selectively programed so that each supervisor receives only the specific information he requires for control of a repair order, a cost code, an area, or a department.

Foremen have acquired a management viewpoint in the control of their costs, workload, and use of personnel. Higher supervision is better informed on cost distribution, cost trends, workload, and manpower usage, and is better able to identify major jobs affecting costs. The system imposed no requirements for additional field reporting, and the data supplied by the machine reports enabled us to release personnel for other assignments who had previously been involved with hand-posting much of this data. The direct objectives of the program have been fully realized, and there have been many supplemental benefits, such as more accurate field reporting, better estimating of jobs, closer observance of authorization limits on work requests, and the intangible but extremely important benefits resulting from a better-informed organization.

Key Words For Indexing

Areas/Location, Communications, Computers, Costs, Data, Estimates, Expenditures, Facilities, Jobs, Labor, Maintenance, Materials, Orders, Personnel, Repairing, Reports, Supervision, Work

ACKNOWLEDGMENT

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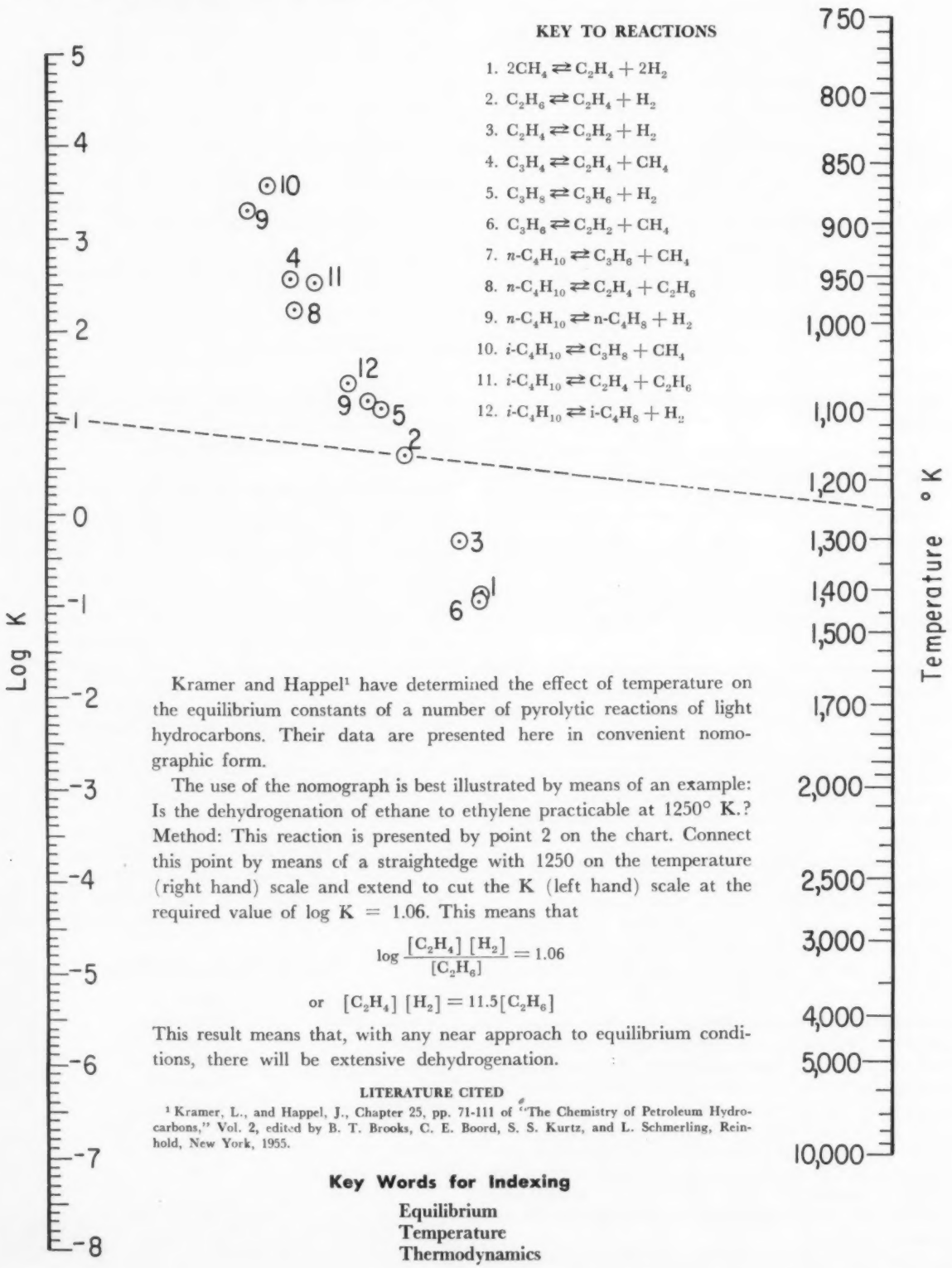
How Temperature Affects Reaction Ks

George E. Mapstone, Johannesburg, South Africa



Kramer and Happel[1] have determined the effect of temperature on the equilibrium constants of a number of pyrolytic reactions of light hydrocarbons. Their data are presented here in convenient nomographic form.

The use of the nomograph is best illustrated by means of an example: Is the dehydrogenation of ethane to ethylene practicable at 1250° K.? Method: This reaction is presented by point 2 on the chart. Connect this point by means of a straightedge with 1250 on the temperature (right hand) scale and extend to cut the K (left hand) scale at the required value of log K = 1.06. This means that

$$\log \frac{[C_2H_4]\,[H_2]}{[C_2H_6]} = 1.06$$

$$\text{or} \quad [C_2H_4]\,[H_2] = 11.5[C_2H_6]$$

This result means that, with any near approach to equilibrium conditions, there will be extensive dehydrogenation.

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Key Words for Indexing

Equilibrium
Temperature
Thermodynamics

Measure Boiling Points Continuously

Here's what you can expect from on-stream analyzers designed to measure boiling points. They are accurate enough to gain operator confidence and give more consistent results than laboratory apparatus

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Six process stream analyzers were installed on a combination distillation unit to monitor its performance. The analyzers were tested over a two-month period by substituting standard samples in place of the plant streams normally monitored. It was determined that three analyzers were outstanding with 90 percent of their readings deviating from the average by not over 2°F. With only one exception, all of the analyzers gave more consistent results than the laboratory distillation apparatus.

Two of the analyzers used are commercial instruments and the other four are Sun Oil Company designs. The analyzers follow the 50-percent boiling point of the straight-run gasoline cut, the 90-percent boiling point of the catalytic gasoline, the 95-percent boiling point of the light naphtha cut, the 10-percent boiling point and end point of the furnace oil cut, and the fraction of light gas oil cut which boils below 440°F.

The combination distillation unit used in this test has a capacity of 65,000 barrels per day. Sour crude from the Middle East and Venezuela is the principal charge to the unit.

STREAM ANALYSES COMPARED WITH LAB RESULTS

Routine Plant Control Samples. During normal operation of the plant distillation units, samples of each of the product streams are taken every eight hours by the plant operators and sent to the refinery laboratory for test distillations by ASTM procedures D-86 and D-285. Performance of four of the analyzers was evaluated by comparing the analyzer records with the results from the laboratory over a six-month period, from March to August 1960. The comparison was made by calculating the difference between the analyzer reading and the laboratory result for each sample and averaging these differences to determine an average offset for a particular period of time: usually two weeks to one month. The offset was added to the analyzer reading on each sample to give a corrected analyzer reading. Differences between the corrected analyzer readings and the laboratory results are deviations used as a basis for evaluation.

A large amount of data on deviations calculated in this way were obtained. The first and second columns of Tables 1 and 2 compare the results obtained by the end point analyzer and the 50-percent point analyzer. The worth of this information, however, is questionable because of the uncertainty of sample identity and the error inherent in a single laboratory distillation.

Table 1—Analyzer For End Points—Agreement of Corrected Analyzer Readings With Laboratory Tests

	PERCENT OF ANALYZER READINGS CHECKING WITHIN DESIGNATED RANGE		
Range, °F	Routine Plant Control Samples	Samples From Analyzer Loop	Readings On Standard Samples
2	23	39	53
4	43	70	67
6	62	93	86
8	74	93	100
10	83	100	
15	93		
20	100		

Table 2—Analyzer For 50% Boiling Points—Agreement of Corrected Analyzer Readings With Laboratory Tests

	PERCENT OF ANALYZER READINGS CHECKING WITHIN DESIGNATED RANGE		
Range, °F	Routine Plant Control Samples	Samples From Analyzer Loop	Readings On Standard Samples
0	2	24	28
1	33	65	63
2	53	83	94
4	73	95	97
6	98	100	100
8	100		

Samples From the Analyzer Loop. The question on sample identity can be eliminated by drawing the sample from the analyzer loop and marking the analyzer record simultaneously. Laboratory error can be detected by making check distillations. Deviations determined in this manner were calculated from a limited amount of data, and are reported in the third columns of Tables 1 and 2. This information shows agreement with the laboratory is considerably better when samples are drawn from the loop and check distillations are made.

This method of evaluating analyzer performance is not without question as to the validity of the results. There is no positive assurance that the average offset is the proper correction to apply to individual readings irrespective of the value of the reading. It appears likely that the offset will vary with the ASTM distillation range of the product and the slope of the distillation curve.

Unless the variations in the product stream to be analyzed are small, application of a constant offset may give a poor correlation with laboratory results.

Readings on Standard Samples. Another method of evaluating the performance of distillation analyzers is

applied by switching the feed to the analyzer from the product stream normally run to a standard sample. If the variables affecting the analyzer reading have not changed, the analyzer should give the same reading whenever it is switched to the standard sample. Results of this method applied to two analyzers are given in the fourth columns of Tables 1 and 2.

Offset between the average laboratory distillations of the standard and the analyzer reading will remain constant unless the standard undergoes changes during its life by loss of light ends or by chemical changes which alter the nature of the material. Deviations determined in this manner are the least of the three methods.

HOW GOOD ARE THE ANALYZERS

During February and March of 1961 each of the six boiling-point analyzers operated continuously on a stream from the unit. At intervals of one to five days, the analyzer was switched to a standard sample. After a sufficient time for stability, a reading was recorded and compared with laboratory results. Laboratory distillations of the standards are reported in Table 3 as averages of the number of determinations given in the last column of the table.

Table 3—Laboratory Distillations of Standard Samples

ASTM D-86, EVAPORATED BASIS

	TEMPERATURE, °F						No. of Determinations
	Initial Boiling Point	10%	50%	90%	95%	End Point	
Crude Tower Gasoline	68	123	217	291	...	348	9
Crude Tower Naphtha	283	311	334	361	370	387	9
Crude Tower Naphtha	297	316	337	369	382	406	8
Crude Tower Furnace Oil	366	401	425	448	459	480	12
Catalytic Gasoline	68	117	235	363	...	408	7
Udex Raffinate	155	166	178	208	223	268	8
Reformer Charge	284	298	316	353	367	399	8
Heavy Naphtha	346	390	415	440	448	460	6
Light Furnace Oil	267	322	381	448	469	493	8
Reformer Gasoline	129	219	301	357	384	435	8

ASTM D-285, MODIFIED PROCEDURE

	Initial Boiling Point, °F	Percent Distillate Below 410° F	Percent Distillate Below 440° F	Number of Determinations
Crude Tower Gas Oil	343	1.9	5.0	10

Analyzer for 50 Percent Boiling Points. This instrument normally operates on the crude tower gasoline stream. It was run on three different standards for checking during the test period with a total of twenty-nine readings made. The first standard was crude tower gasoline itself. Two additional standards differed considerably from the normal stream with respect to boiling range and slope. These differences are reflected in the offsets given in the third column of Table 4. Despite wide variation in standards, 94 percent of the corrected analyzer readings were within 2°F of the laboratory average 50 percent point.

Analyzer for 10 Percent Boiling Points. Crude tower furnace oil stream is normally fed to the 10-percent boiling point analyzer. During the test period, three standards were checked: a similar furnace oil, another furnace oil with a light front, and crude tower naphtha. See Table 5. Results from 29 checks show all of the corrected readings agree with the laboratory average 10 percent points within 2°F.

Table 4—Analyzer For 50% Boiling Points
(Results With Standard Samples, Feb.-Mar. 1961)

Standard	Number of Readings	Average Offset °F	NUMBER OF READINGS CHECKING WITHIN:					
			0° F	1° F	2° F	4° F	6° F	8° F
Crude Tower Gasoline 217° F @ 50 Percent	14	+26	6	2	4	1	0	1
Udex Raffinate 178° F @ 50 Percent	8	+ 3	1	4	3	0	0	0
Reformer Gasoline 301° F @ 50 Percent	7	+20	1	4	2	0	0	0
Total	29		8	10	9	1	0	1
Percent of Total			28	35	31	3	0	3
Cumulative Percent			28	63	94	97	97	100

Table 5—Analyzer For 10% Boiling Points
(Results With Standard Samples, Feb.-Mar. 1961)

Standard	Number of Readings	Average Offset °F	No. of Readings Checking Within:		
			0° F	1° F	2° F
Crude Tower Furnace Oil 401° F @ 10 Percent	15	+2	8	5	2
Light Furnace Oil 322° F @ 10 Percent	8	+3	1	6	1
Crude Tower Naphtha 311° F @ 10 Percent	6	—2	5	1	0
Total	29		14	12	3
Percent of Total			48	42	10
Cumulative Percent			48	90	100

Analyzer for 90 Percent Boiling Points. This instrument operates on the synthetic tower gasoline stream. It was checked with a similar standard and additional standards of crude tower gasoline and reformer gasoline for a total of 25 checks. As shown in Table 6, about three quarters of the corrected readings were within 6°F of the laboratory 90 percent point and all were within 10°F. This analyzer is relatively new and experience with its operation is necessarily limited. Both the 50 percent point and the 90 percent point analyzer are dependent on the maintenance of constant pumping rates. Rates on the 90 percent analyzer were observed to vary and it is suspected that the raw synthetic gasoline may be responsible for fouling the stainless steel checks in the pumps.

Table 6—Analyzer For 90% Boiling Points
(Results With Standard Samples, Feb.-Mar. 1961)

Standard	Number of Readings	Average Offset °F	NO. OF READINGS CHECKING WITHIN:				
			2° F	4° F	6° F	8° F	10° F
Crude Tower Gasoline 291° F @ 90 Percent	7	+29	4	0	0	1	2
Reformer Gasoline 357° F @ 90 Percent	7	+26	1	1	5	0	0
Catalytic Gasoline 363° F @ 90 Percent	11	+34	1	1	5	2	2
Total	25	....	6	2	10	3	4
Percent of Total	..	....	24	8	40	12	16
Cumulative Percent	..	....	24	32	72	84	100

Analyzer for End Points. One of the commercial end point analyzers operates on the crude tower naphtha stream normally, and was checked with five standards

two of which were of different boiling range than the normal feed. The analyzer was adjusted to agree with the 95 percent point of a crude tower naphtha. Thereafter, no adjustments were made throughout the test period. All of the corrected analyzer readings agreed within 2°F of the laboratory average 95 percent point as shown in Table 7.

Table 7—Analyzer For 95% Boiling Points
(Results With Standard Samples, Feb.-Mar. 1961)

Standard	Number of Readings	Average Offset °F	No. of Readings Checking Within: 0° F	1° F	2° F
Crude Tower Naphtha 382° F @ 95 Percent	7	+2	5	0	2
Crude Tower Naphtha 370° F @ 95 Percent	6	—3	0	5	1
Reformer Charge 369° F @ 95 Percent	6	+6	5	1	0
Heavy Naphtha 448° F @ 95 Percent	6	—10	1	5	0
Crude Tower Furnace Oil 459° F @ 95 Percent	7	—9	2	4	1
Total	32		13	15	4
Percent of Total			41	49	12
Cumulative Percent			41	88	100

The second commercial end point analyzer is normally fed with the crude tower furnace oil stream. During the test period four standards were checked: crude tower furnace oil, a furnace oil with a light front, crude tower naphtha, and a high end point heavy naphtha. Results in Table 8 show about two thirds of the corrected analyzer readings agree within 4°F of the laboratory average end points, and all readings agreed within 8°F. On furnace oil service, this analyzer required cleaning every three weeks. The thermocouple location is critical and when it is replaced it must be positioned carefully to obtain consistent results.

Table 8—Analyzer For End Points
(Results With Standard Samples, Feb.-Mar. 1961)

Standard	Number of Readings	Average Offset °F	NUMBER OF READINGS CHECKING WITHIN: 0° F	1° F	2° F	4° F	6° F	8° F
Crude Tower Furnace Oil 480° F End Point	14	+21	1	2	4	3	2	2
Light Furnace Oil 493° F End Point	10	+37	2	3	2	1	2	0
Crude Tower Naphtha 387° F End Point	6	+ 4	0	0	0	1	3	2
Heavy Naphtha 460° F End Point	6	+ 4	0	1	4	0	0	1
Total	36		3	6	10	5	7	5
Percent of Total			8	17	28	14	19	14
Cumulative Percent			8	25	53	67	86	100

Summary of Temperature Recording Analyzer Results. A comparison of the results from the foregoing temperature-recording analyzers is shown in Figure 1. The first, second, and fourth captioned on the figure demonstrate repeatability within ±2°F and are judged satisfactory for use on the refinery streams normally analyzed. The two remaining analyzers are not as satisfactory, but the difference is not necessarily definitive of performance on all streams.

The end point analyzer ran a furnace oil stream during the test period except for brief intervals on the test sample of naphtha. In view of the effect of coke deposition in the flask and on the thermocouple, it is

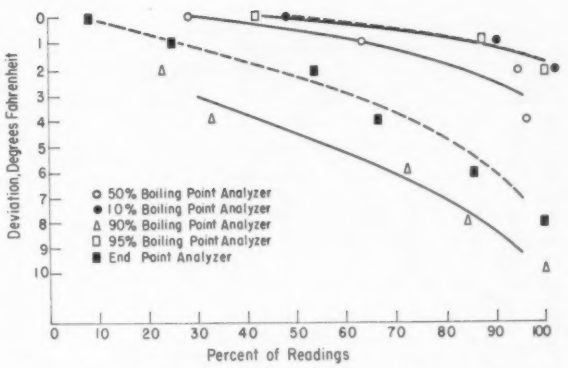

FIGURE 1—Three of the analyzers were judged satisfactory for use on refinery streams that are normally analyzed.

probable that performance would be better on straight run naphtha or gasoline. The 90-percent point analyzer ran untreated catalytic gasoline which, as mentioned before, gave rate trouble by depositing a fouling material on the pump valves. Again, it is probable that performance would be better had the analyzer operated on a stream of straight run material.

Nearly 100 distillations of the standard samples were made in the laboratory in order to arrive at the average test results reported earlier in Table 3. If those test data are separated into groups according to the standard samples run on each analyzer, and deviations from the laboratory average calculated, a comparison can be made with the deviations of the analyzer readings. Such a comparison is summarized in Table 9 which gives maximum deviations of 90 percent of the data from the average results.

Table 9—Performance of Analyzers Compared With Laboratory Results

Analyzers	MAXIMUM DEVIATION OF 90 PERCENT OF DATA FROM AVERAGE RESULTS, °F: Analyzer Readings	Laboratory Tests on Standard Samples
50 Percent Boiling Points	2	3
10 Percent Boiling Points	1	4
90 Percent Boiling Points	8	4
95 Percent Boiling Points	1	3
End Points	6	8

It is evident that nearly all of the analyzer readings are more consistent than the laboratory tests.

Hempel Analyzer. This instrument normally reads the percent of the crude tower gas oil stream distilling under 440°F as determined by a modified ASTM procedure D-285. The laboratory test employs a long necked flask packed with jackchain and exibiting a different degree of fractionation than the instrument, which is a falling film still. For example, some distillate is obtained in the falling film still when the evaporator temperature is considerably lower than the ASTM D-285 initial boiling point. Moreover, much more distillate is obtained from the falling film still at 440°F than from the ASTM still at the same temperature. It was determined experimentally that the evaporator temperature should be 405°F.

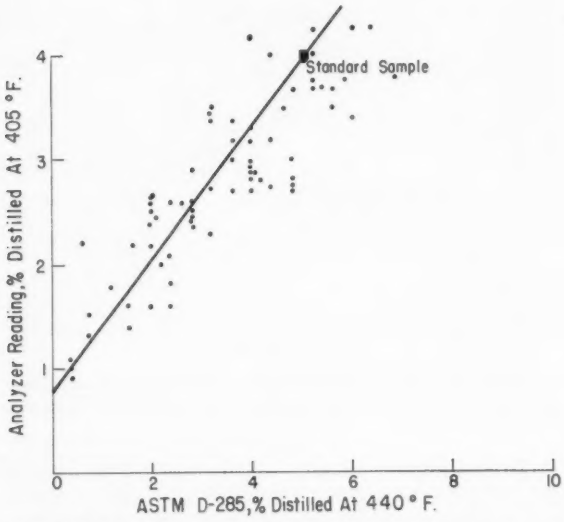

FIGURE 2—Scattering of the results for plant samples of gas oil is affected by sample identity, laboratory error, and water in the stream.

Results for a large number of stream samples are shown in Figure 2. The continuous analyzer records about one percent distilled when the laboratory shows an initial boiling point of 440°F.

Scattering of data in this figure is affected by factors related to sample identity, laboratory error on a single determination, and spurious analyzer readings as a result of water in the plant stream.

A standard sample of gas oil was run through the analyzer producing the data given in Table 10. Results from twelve checks show 92 percent of the corrected analyzer readings agree with the laboratory average Hempel distillations within 0.5 percent distilled.

Table 10—Hempel Analyzer
(Results With Standard Gas Oil)

Standard	Number of Readings	Average Offset Volume Percent	NUMBER OF READINGS CHECKING WITHIN: .1%	.2%	.3%	.4%	.5%	.6%
Crude Tower Gas Oil 5.0 % Boiling Under 440° F	12	+1.0	3	3	2	1	2	1
Percent of Total			25	25	17	8	17	8
Cumulative Percent			25	50	67	75	92	100

HOW THE ANALYZER WORKS

The crude tower gasoline fraction is taken overhead through a water cooled condenser to a reflux accumulator where wet gas and water are separated from the gasoline product. Sample for the analyzer is taken at the reflux pump. A similar arrangement is used to sample the synthetic tower gasoline.

Crude tower naphtha and gas oil are side stream fractions stripped with steam in separate towers. Furnace oil is steam stripped within the crude tower. Analyzer samples from these streams are taken at the pumps which transfer the stripped products to storage.

The sample streams are brought to the analyzer location in loops of half-inch pipe connected from the discharge to the suction side of the respective pumps. All of the analyzers are located remotely from the process pumps following the general arrangement of Figure 3. Rapid circulation in the sample loops minimizes the time lag between analyzer and process. The analyzers are connected to the loops by relatively short lengths of small bore tubing.

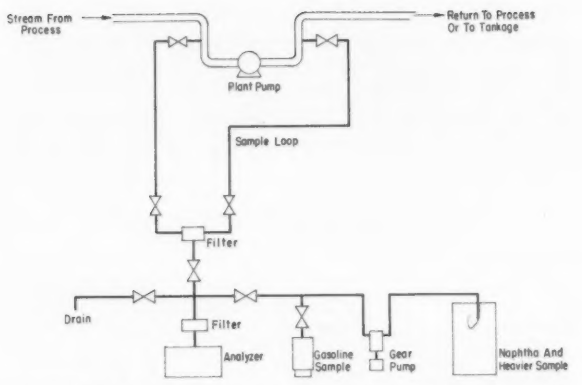

FIGURE 3—All of the analyzers are located remotely from the process pumps.

All of the analyzers are presently located in a compressor room where they are protected from the weather. At one time, the gasoline 50-percent point analyzer was installed out of doors near the reflux pump to avoid bringing the volatile sample indoors. Experience with this analyzer over a one-year period has proved conclusively the desirability of weather protection. Future installations will include shelters for the analyzers wherever possible.

Shown on Figure 3 is the provision for introducing a standard sample for a check determination.

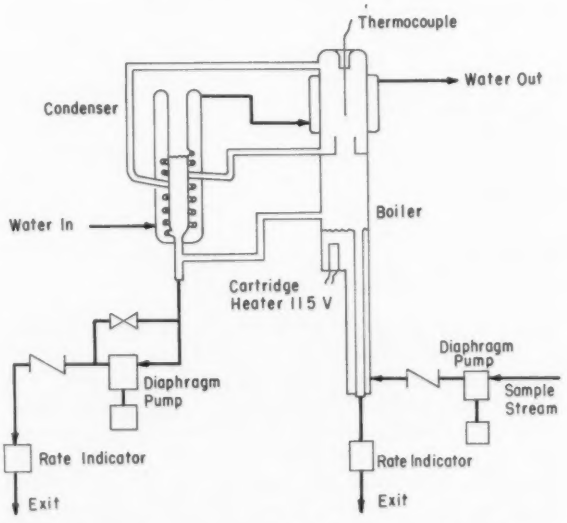

FIGURE 4—The 50 percent boiling point analyzer is a continuous flash evaporator.

Analyzer for 50 Percent Boiling Points. This analyzer (Figure 4) is a single stage still to which sample is fed

at a constant rate by means of a positive displacement pump and boiled at constant heat input. Distillate is removed from the condensate from a water cooled condenser at a constant rate equal to 50 percent of the feed rate by a second positive displacement pump. Excess condensate is returned to the boiler as reflux. The remaining 50 percent of the feed is removed as bottoms from an overflow line in the boiler. Temperature of the vapor from the boiler can be correlated with the ASTM 50 percent point.

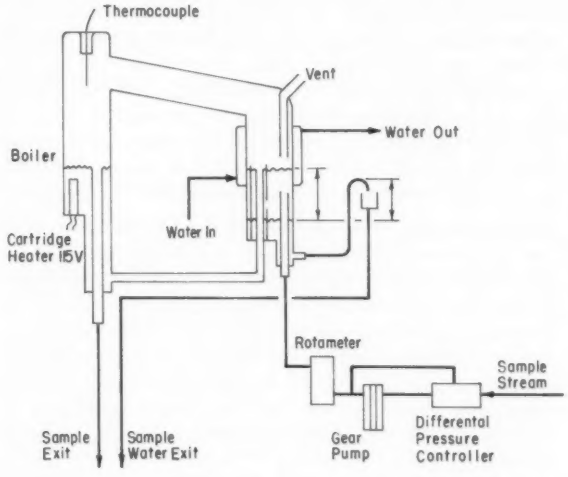

FIGURE 5—With proper design and positioning of the thermocouple, the analyzer can record the 10 percent boiling point of a sample.

Analyzer for 10 Percent Boiling Points. Charge to this analyzer (Figure 5) is pumped by a gear pump under constant differential pressure and enters a disengaging chamber designed to separate and dispose of water in the sample. From the water separation stage, the sample flows to a boiler equipped with a cartridge heater and an overflow line. Vapor from the boiler is condensed and returned to the boiler by way of the disengaging chamber. All of the sample leaves the boiler through the overflow line. With proper design and positioning of the thermocouple, the analyzer can record the 10 percent boiling point of the sample.

Analyzer for 90 Percent Boiling Points. The 90-percent boiling point analyzer (Figure 6) is essentially a two-stage still. The first stage is similar to the 50-percent boiling point analyzer described previously and is designed to condense low boiling material with tap water. Effluent from the first stage flows by gravity to the second stage from which distillate is removed by a third positive displacement pump. The distillate pumps are adjusted at a fixed ratio to permit 10 percent of the feed to overflow from the second stage. Temperature of the vapor from the second stage boiler can be correlated with ASTM 90 percent point. Use of a single stage still for correlation with 90 percent point is not recommended because the analyzer temperature is relatively unaffected by substantial differences in ASTM 90 percent point.

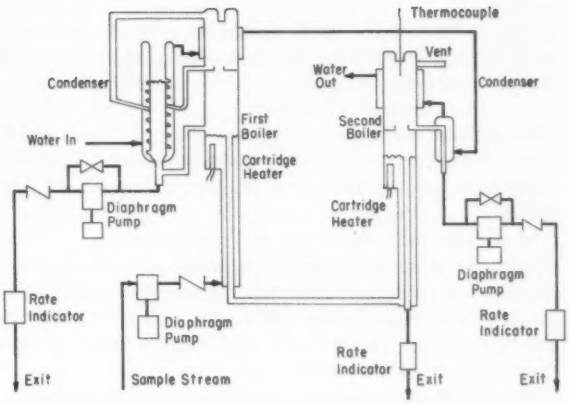

FIGURE 6—Two boilers are used for the 90 percent boiling point analyzer.

Analyzers for End Points. Two end point analyzers available commercially are included in the installation. Descriptions of these analyzers are excluded from this report.

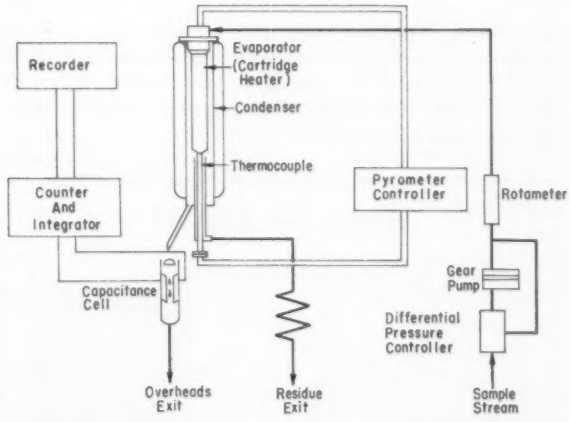

FIGURE 7—The Hempel analyzer is a falling film evaporator.

Analyzer for Hempel Determinations. This instrument (Figure 7) is a falling film flash evaporator. Sample is introduced at a constant rate by a gear pump under constant differential pressure. The feed enters the top of a vertical heated rod maintained at constant temperature. Light ends in the feed evaporate and condense on a water jacketed condenser which surrounds the evaporator. The distillate flows through a drop counter which records the flow rate as percent distilled. The result is correlated with the percent boiling below 440°F as determined by ASTM distillation D-285 (Hempel distillation).

SOME PROBLEMS TO WATCH

Water. Sample streams circulating in the loops connecting the analyzers with the process are saturated

with water. The cooling which the sample undergoes before it reaches the analyzer causes some of the water to drop out of solution. This free water can be removed from the small stream going to the analyzer by means of a small separator. Suspended water can be removed from certain streams by coalescing in a porous solid. Nevertheless, enough water remains to cause trouble with analyzers which monitor the front end of the sample.

A commercial 10-percent boiling point analyzer was taken out of service because accumulation of water in its condenser caused frequent upsets by periodically flashing the boiler. This difficulty was overcome by the Sun designed instrument which can tolerate considerable water in the feed.

The Hempel analyzer is susceptible to water collecting in the condenser, running through the drop counter, and momentarily recording a rapid distillate rate. This difficulty can be largely overcome by using a stream of air to cool the condenser at a rate sufficient to allow the water to escape as vapor without losing an appreciable amount of the light ends of the gas oil.

Analyzer readings on the standard samples are seldom affected by water because storage of the sample in a drum permits suspended water to settle and cooling results in a lowered content of dissolved water.

Corrosion. Gasolines from sour crudes contain both water and hydrogen sulfide which necessitate the use of all stainless steel construction with welded joints in the analyzers. Other distillates contain sulfur and require similar construction.

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Donnell

Coking. Accumulation of coke in the flask, in the stillhead, and on the thermocouple of the commercial end point analyzer has been mentioned above. In furnace oil service, the analyzer could be operated for several weeks without cleaning. Two similar analyzers were operated for several months on catalytic gas oil at end points around 650°F. In this service the instruments coked up within two days. The analyzers were withdrawn from this application.

Boiler Heaters. One problem with the commercial 95-percent point analyzer has been short heater life. Heaters have lasted only several months in continuous operation. Replacement is not difficult, but the analyzer requires several hours to cool before replacing the heater and several more hours to get back on stream.

Another end point analyzer has been subject to burned out heaters. In furnace oil service, heater life has been sufficiently long to be acceptable, but in the catalytic gas oil service at higher end points, the heaters rarely lasted more than a few weeks.

Thermocouples. The thermocouples supplied as standard equipment with one of the end point analyzers are extremely fragile. Mechanical breakage and corrosion of the fine thermocouple wires limited the life of the thermocouples to a matter of weeks. They have been replaced with 1/16-inch diameter armored pencil-type couples which are still in service after more than six months of operation, and the end-points appear to be as reproducible as those obtained with the original thermocouples.

Cooling Water. With the 50-percent point analyzer installed in an exposed location, cooling water lines had to be steam-traced to prevent freezing in winter. With warm condenser water, light-ends in the sample were lost. Since the liquid distillate rate was maintained constant, the actual total percent distilled (liquid + uncondensed vapor) increased, and the point recorded was not the true 50 percent point. Installation in a sheltered location will overcome this problem, as well as making maintenance easier during inclement weather.

Offset. It is apparent from the tables that offset, or the correction to be applied to the analyzer reading to arrive at the laboratory result, varies considerably with the nature of the sample with respect to boiling range and slope. This variation itself is considered a problem to be overcome in subsequent designs of additional analyzers. If a refinery stream undergoes small variation in boiling range, the offset may be expected to change only an insignificant amount. The user will have to determine for himself the magnitude of offset changes for customary variations in stream boiling range.

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Key Words for Indexing

Analyzers
Boiling points
Continuous
Distillation
Equipment
Instrumentation
Monitors
Testing

PART 26

Automation Today

Computers are often the best and sometimes the only way to implement proper control of a process. Look over this discussion of analog and digital computers to see when one or the other can handle your process control problems

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Past discussions of imposed nonlinear control features and of adaptive control leads us naturally to our present subject of control by computers. Such control is probably the best and often the only possible way of implementing these types of regulation on the process. In addition it can allow a concurrent optimizing of the operation of the process according to some economic criterion. While computer control is a popular subject in the technical literature, its application is still very much in a state of flux, both because of the rapid developments in the computers and control hardware themselves and because very little actual data on plant experience is available as yet in the literature.

WHAT IS COMPUTER CONTROL?

Computer control as applied to the process industries can have many definitions depending upon the outlook of the author of the particular article one happens to be reading. This is because there are many "degrees" or "levels" of application of "computers" to the control of processes and correspondingly of the point the author wishes to make.

Thus computer control may be classified according to the type of computer used as: analog, digital or hybrid (combined analog and digital characteristics).

The digital types are also classified generally according to size and system complexity. In addition the digital and hybrid installations may be classified according to the degree of their direct inclusion into the control loop. Such a classification is as follows:

- process monitoring with data reduction and logging
- off-line and open-loop optimization on a long term basis
- on-line but open-loop optimization and control on a short term basis (sometimes called "operator guide" control)
- on-line and either open- or closed-loop steady-state supervision of plant control according to external criteria
- closed-loop steady-state optimization on-line; and dynamic optimization and control (analog computers are generally used in a closed-loop control situation)

Open loop control uses the computer to calculate the required set points of regular plant instrumentation. Then in contrast to the closed-loop system, the computor has no direct connection to the process, and the operator must make those corrections to the instrument settings which are suggested by the computer's work. Depending upon the immediacy of the control corrections which the computer is programmed to calculate it may or may not need to be installed in the actual vicinity of the process. Thus if optimum operating procedures for the process are being computed on a daily, weekly, or longer basis, such work can readily be done on the company's regular accounting or scientific computers wherever they may be installed. It would thus be used off-line.

If, on the other hand, an hourly or oftener adjustment of plant controls is desired, then the required interference with the regular operation of the established computers makes the installation of a special computer for the control calculations desirable. If connected directly to the process this would be an on-line installation.

Steady-state optimization, on-line and closed-loop, allows the computer to determine a new best operating level for the process if exterior conditions require such changes in order to maintain the process operation at some optimum criteria, usually economic. Such optimizations are computed under the assumption that the process is at some steady-state and can be instantaneously transferred from one steady-state level to another. Such an assumption is necessary to transform all process operating equations to algebraic form for ready solution on the computer.

Dynamic optimization and control adds one more level of sophistication to the steady-state optimization just mentioned. Thus the process is not only maintained at its optimum performance level while in the steady-state regime but the change from one operating level to another is also made in such a way as to best satisfy the established over-all control criteria, which is usually an economic condition. Such control is at present mainly of academic interest due to the extremely large and powerful computing capacity which is required to achieve it. However, its practical attainment in the foreseeable future is certainly highly possible. When dynamic optimization is used it will find particular application in cyclical catalytic processes, and in the batch processing of plastics both of which can be very critical of the process path being followed.

JUSTIFICATION OF DIGITAL COMPUTER CONTROL

Much of the available information concerning present day digital process control computers concern their use for supervisory control and steady-state optimization functions. Along with the job of maintaining an

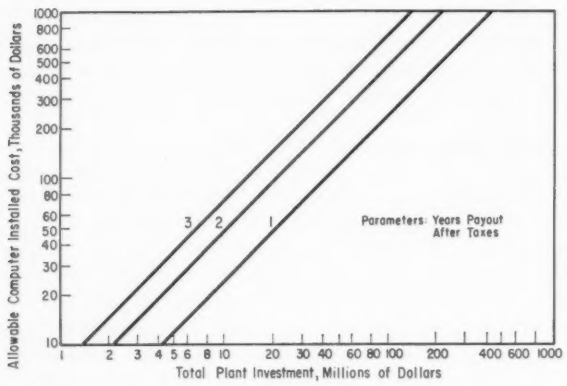

FIGURE 186—Use this chart to figure how much you can afford to pay for a computer installation that will give 0.5 percent return on your original investment.

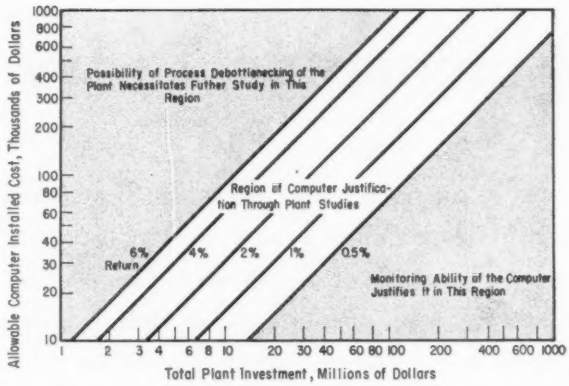
Allowable Computer Installed Cost, Thousands of Dollars
Total Plant Investment, Millions of Dollars
Possibility of Process Debottlenecking of the Plant Necessitates Futher Study in This Region
Region of Computer Justification Through Plant Studies
6% Return
4%
2%
1%
0.5%
Monitoring Ability of the Computer Justifies It in This Region

FIGURE 187—If you assume a three-year payout on the computer installation, this chart will show you how much you can afford to pay for the computer to get a given return on total plant investment before taxes.

economic balance of the plant's operation, there are several additional tasks to which they may readily be applied without hindering the performance of their primary function of optimization. Some of these are:

- Modification of plant mathematical models on a regular basis to account for such effects as rapid catalyst deterioration; tar buildup; heat exchanger, condenser, or column fouling and others of a similar nature. These coefficients in the plant economic control model must change significantly over periods of as short as a few or even one day to preclude the use of off-line computers for such tasks.
- Where the plant mathematical model is too complex, i.e., the plant interactions are too complex, or their kinetics are too detailed, etc., for special analog type computers to be designed for the task.
- Where the process or kinetic model is incomplete in that statistical analysis must be regularly made to determine and upgrade kinetic and other mathematical model coefficients and terms.
- Data logging, data monitoring and data processing and evaluation. Such tasks are subsidiary to the digital computer's main task but may add justification for its use.
- Statistical analyses of plant operating data where these must be carried out on a regular repetitive basis.
- Regulation of cyclic operations where variable time periods within the cycle are necessary. Batch operations employing catalysts of varying activities are of this type.
- Emergency procedures such as partial plant shutdowns.

Let us now develop some basis for the economic and technical justification which can be put forward for the use of process control computers as steady-state economic optimizers in chemical processing plants and petroleum refineries.

Where Are Computers Justifiable? If we make some generalizations concerning the applicability of process control computers, we can readily diagram the relationship of digital process control computer installed cost to the process plant total investment and the required return on total investment before taxes which is attributable directly to the work of the digital control computer.

The resulting general statements are:

- A return on total plant investment of at least 0.5 percent per annum is probably possible on any process due entirely to the monitoring and long term economic optimizing abilities of the computer alone.
- If a plant systems study shows that a return of greater than about 6 percent per annum is possible, serious engineering study should be given to the possibilities of process de-bottlenecking or process improvement work in the plant. After this, the plant should be restudied to determine the remaining return on investment which can still be credited to the computer. If such high returns are possible the plant was obviously not designed originally for optimum compatibility of its constituent units.

Such statements are of course based upon the common rule that a plant's annual production is approximately equal to its capital cost. The capital cost figure is used here since it is usually more readily available and is also the figure against which profits are compared.

While the actual limits used here may vary from company to company depending upon accounting and management practices, a relationship such as suggested above appears to hold throughout our industry. With these conditions in mind, the allowable computer size versus plant investment is shown in Figure 186 where only the computer's monitoring ability is to be recognized and none of its special control abilities are used. Parameters are shown for one, two and three year payouts after taxes.

The range of allowable computer installed costs versus plant total investment between our limits of 0.5 and 6 percent return, with the locations of intermediate return rates are indicated in Figure 187. These data are for a three-year payout. The percent return versus plant over-all investment is shown in Figure 188 in the areas

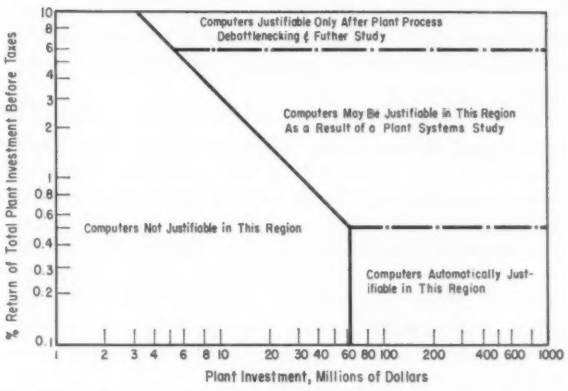
Computers Justifiable Only After Plant Process Debottlenecking & Futher Study
Computers May Be Justifiable in This Region As a Result of a Plant Systems Study
Computers Not Justifiable in This Region
Computers Automatically Justifiable in This Region
% Return of Total Plant Investment Before Taxes
Plant Investment, Millions of Dollars

FIGURE 188—Here are the areas for computer justification by present day standards: a two-year payout of a computer costing $300,000 installed.

where computers may or may not be justified. Figure 188 represents what is probably the present day standard installation, that is, one costing about $300,000 complete and requiring a two-year payout after taxes.

The most obvious points brought out by these plots are first, the extreme dependence upon plant size or better plant total investment, and second, the inverse effect of computer installed cost. From this one can immediately conclude two things: computer control will always be more important to the petroleum refineries than to chemical plants and computer control will be much easier to justify on new plants. The first is true because of the generally much larger size and higher throughputs of the refineries. Also within the chemical companies, petrochemical installations will be the most susceptible, again because they are usually larger. New plants are more susceptible to computer control than old because no tremendous outlay of capital is required for instrumentation just to make the computer and plant compatible. If properly planned, the instrumentation for a new plant to allow computer control should be only a little more expensive than that planned to operate without it. Thus in contrast to the older plant where the capital investment includes both computer and instrumentation, in the new plant the required investment, since it includes only the computer and a small amount of associated hardware, may be only one-third to one-half that of the older installations.

There are other factors which should be kept in mind while establishing the economic justification for computer control. They relate to establishing the part of the gain from computer control which can be rightfully credited directly to the computer itself and are:

- Great gain can sometimes be made from the installation of analytical instrumentation alone. Even though such instrumentation is usually necessary to allow digital computer control to be applied, economic gains really attributable specifically to the more modern instrumentation should not be credited to the computer.
- Some gains are attributable only to the specific new knowledge and resulting adjustment of plant operating methods which frequently occurs as a result of a complete plant systems study and which could be applied whether the computer had been purchased or not.
- For cases where some of the coefficients of the plant mathematical model are unknown or variable and it is contemplated that the computer will be necessary to obtain them, a different situation usually exists once the computer has determined these data or established a correlation for them. Could the plant be converted to some simpler control system at that time? If so, serious consideration should be given to a temporary installation of the computer using one of the several rental systems available rather than an outright purchase of the machine.

Some technical criteria also should be considered when justifying computer control. The computations which the computer is to carry out must be of such complexity that no simpler device could perform them sufficiently well to capture all or most of the contemplated returns. That is, the following possibilities must be considered and discarded as impractical:

- **Nomographs**—Solution of simple algebraic equations can often be carried out by means of nomographs or tables. Thus a certain definite level of complexity is necessary to justify the computer.
- **Analog Computers**—Systems of differential equations or of algebraic equations expressed in differential form are rapidly solved on analog computers. For the type of control tasks contemplated today this way will be much cheaper than the corresponding digital machines. However if the optimizing routine includes the adjustment of several of the coefficients of the plant mathematical model, analogs will be impractical and the digital machine will be necessary.
- **Off-Line Digital Computers**—If the computations carried out by the control computer must be repeated at intervals of less than about one hour, off-line computation would be impractical, otherwise it must be considered a definite possibility and a factor in the justification of the on-line or in-plant machine.

This is the time to emphasize the necessity for making a thorough plant systems study and for developing a mathematical model of the plant which is as complete and as exact as possible.[14] This is necessary both to permit the proper programing of the machine and also to thoroughly document the claimed economic justification for its use.

It has often been remarked by systems people that there has never been a thorough plant study which has not paid for itself in new knowledge concerning the process and its operation whether a computer was actually purchased or not. While only about one fourth to one fifth of the chemical plant studies to date have uncovered potentially profitable digital computer applications[7] their uncovering of new plant knowledge has made them a very worthwhile endeavor for our systems groups.

It has been mentioned by some in taking a quick survey of the field of computer control that our chances

of justifying a computer are inversely proportional to our degree of knowledge of the process and its kinetics. While this is of course an exaggeration it is nevertheless true that the necessity for making a statistical analysis as part of the computer's task in optimizing the process greatly increases the possibility of a justification for its use. If off-line analog or digital computation can, by means of theoretical considerations, uncover the kinetic or mass transfer relationship which is the basis for the required statistical evaluation then a simpler control system often is sufficient.

Several articles have appeared recently in the literature giving fairly detailed discussions of actual process control computer installations. These include the on-line control of a vinyl chloride plant[10] and an ammonia plant.[4] The off-line analysis of an ethylene cracking furnace[11] and the off-line optimization of a crude still.[5] Two other articles have rather thoroughly probed the present day applications and future of computer control.[7,15] The available computers have also been classified according to their capabilities.[6]

THE FUTURE OF COMPUTER CONTROL

The Place of Analog Computers. Special analog computers have been designed to carry out complex control functions. One has been designed to correct for the effect of ambient conditions on the operation of a fin-fan cooler used as a condenser on a distillation column.[9] Another has been designed to make an over-all heat balance about a polymerization reactor.[13] Our investigations of our processes has to date revealed many potential applications for such specialized controllers, particularly in the control of chemical reactors and in the modification, interpretation and presentation of plant data. Also in contrast to the larger digital computer installations, which because of their complexity and size are usually one of a kind projects, the analog computer-controller designs often are transferable directly from one process to the next. It is this author's feeling that this can be a very active field in the future once study has shown the best form which these devices should take for maximum flexibility of application from one process to another.

Dynamic or Real-Time Control by Digital Computer. So far digital computer control has only been applied to static or steady-state control of chemical processes. What about their use for controlling processes which are subject to rapidly changing operating conditions such as cyclic or batch reactors or tubular reactors with variable feed conditions? The reader should particularly note that the examples considered in this question have all been reactor situations. Only reactors appear to have the non-monotonic or exponentially monotonic behavior which could possibly necessitate on-line dynamic control. All other processing operations appear to exhibit an overdamped monotonic response which can be adequately handled by conventional instrumentation with the possible aid of supervisory optimizers. Note that reactor, as used here, is the general term which includes the reforming, cracking, and etc., operations of the petroleum refinery as well as the various reactors and furnaces in the chemical plant.

In an attempt to evaluate the above question, a generalized chemical processing problem has been formulated and presented to the computer manufacturers for their use.[16] Study of this model has revealed that dynamic control of such situations with the inclusion of an economic optimization feature will be an extremely complex calculation even for relatively simple cases.[1,3,8] Thus present day process control computers are probably much too small (i.e., too little storage) and too slow in their computing speed to be used for this purpose.

Combined Analog and Digital Installations. Several authors have speculated on the possible future applications of computers to plant control. They predict the rapid computing ability of the digital computer and its known capability of handling large systems of equations in such types of computations as linear programming[12] will be used to carry out a continual over-all optimization of the plant's operation. Immediate control of the plant would be vested in several small special purpose analog computer controllers which, with the aid of special small digital computers for the reduction of data from the analysis of multicomponent mixtures, would carry out the minute-by-minute control of the plant. The large digital computer would then regularly upgrade the operation of the subsidiary machines by resetting their set points or operating levels. Such a system thus could take advantage of the ability of each type of computer to its maximum extent.

Key Words for Indexing

Analogs	Economics
Computers	Forecasting
Controllers	Instrumentation
Costs	Investment
Depreciation	Monitors
Digital	Return on investment

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Add Ethylene Production for Profit

Here is how to add a 132 million-pound-per-year ethylene plant to an existing 50,000-bpsd refinery and increase profits without upsetting fuel balance and gasoline pool

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This study indicates that production of ethylene at a refinery location is attractive since it:

- **Utilizes existing products**
- **Does not pose a marketing problem for either excess existing products or new products**
- **Provides a starting point for future byproducts petrochemicals**
- **Provides a means of shifting refinery balances to take advantage of varying market situations.**

The Mid-Continent area appears to be at no disadvantage relative to the Gulf Coast based on the indicated pricing structures. Since the bulk of the ethylene on the Gulf Coast finds its way into products that are marketed elsewhere, the Mid-Continent location should also fetch a slightly higher ethylene price.

The rapid growth of ethylene as a chemical raw material is well known and requires no elaboration. The location of the bulk of this ethylene production on the Gulf Coast is also an established fact and the reasons for this have been discussed in detail elsewhere.[2,4] Availability of low cost natural gas fuel and the use of hydrocarbons derived therefrom as feedstock have been chief contributing factors. Recently, however, light straight run naphtha, which has been a principal source of ethylene in Europe, has become an ethylene feedstock source on the Gulf Coast. The use of this, or similar liquid petroleum feedstocks sharply increases the effect of byproduct values on the ethylene manufacturing cost[1] and, more significantly, reduces or even reverses the feedstock cost advantage the Gulf Coast enjoys.

Production of increased byproducts, can offer a considerable incentive if these may be utilized as petrochemical raw materials. However, if markets are not immediately available their initial disposal may pose a problem. The existing refinery, with its established markets, has the capability of disposing or consuming the ethylene byproducts without requiring new petrochemical markets or seriously dislocating existing refinery balances. This approach also permits sound evaluation of future utilization of these byproducts as petrochemical intermediates as such markets develop.

Economics. It is the purpose of this paper to examine the economics of integrating an ethylene production facility into an existing medium-sized refinery. The Mid-Continent region will be used as a basis, but for comparison the evaluation will also include a similar refinery operating on the Gulf Coast with the same crude.

The following limitations on ethylene capacity are imposed in this study:

1. No refinery product will be produced in excess of its pre-ethylene unit rate
2. Apart from economic considerations, pyrolysis will be limited to feedstocks having wide prior commercial utilization
3. Ethylene production will be limited by utilizing only those feedstocks produced in normal refinery operations. The purchase of external feedstocks may be profitable in certain situations as indicated in a subsequent section.

THE REFINERY

Figure 1 shows the refining scheme used as a starting point for this study. Fifty thousand bpsd of 35° API Mid-Continent type crude is processed in conventional

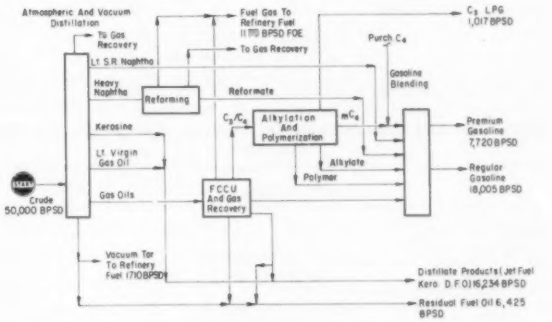

FIGURE 1—This refining scheme, although not representing an optimum new refinery, is typical for the example discussed here.

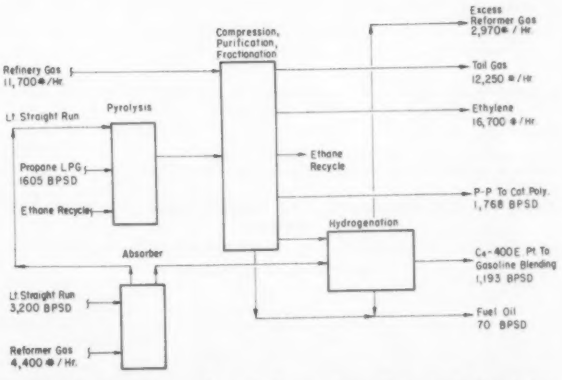

FIGURE 2—Shows the ethylene plant flow and the interrelation of refinery streams and products for minimum effect on fuel products.

units to yield the indicated product slate. Included in the refinery are the following units:

- 50,000 bpsd atmospheric topping and vacuum unit.
- 9000 bpsd platinum reformer normally producing an 87 F-1 clear octane number reformate.
- 21,000 bpsd fluid catalytic cracking unit operating at 61 volume percent conversion.
- Gas recovery facilities achieving 85 percent C_3 recovery.
- A catalytic polymerization unit, originally designed to produce 1,800 bpsd of polymer, presently operating at reduced throughput due to the subsequent addition of alkylation.
- 2,200 bpsd butylene alkylation unit.

This refining sequence does not represent an optimum new refinery, but is based on a typical current product structure.

TABLE 1—132,500,000 Lbs/Yr Ethylene Unit at 50,000-BPSD Refinery

MATERIAL BALANCE
Lbs/Hr

Input		Output	
Reformer Gas	4,430	Reformer Gas	2,970
Refinery Gas	11,700	Tail Gas	12,250
Light Straight Run	31,740	Ethylene	16,734
Propane LPG (from cat. poly.)	11,906	Ethane Recycle	10,180
Ethane Pyrolysis Recycle	10,180	PP (to cat. poly.)	13,290
		C_4 to 400 End Point	12,486
		Fuel Oil	1,047
		Loses and Refrigeration Makeup	999
	69,956		69,956

TABLE 2—132,500,000 Lbs/Yr Ethylene Unit at 50,000-BPSD Refinery

Utilities

Fuel MM BTU/Hr	277
Steam Lbs/Hr	
600 Psig (750° F)	
Produced in Unit	134,200
Consumption	
Condensing Turbines	91,600
Back Pressure Turbine	42,600
	134,200
175 Psig	
From Turbine Exhaust	35,700
Consumption	35,700
50 Psig	
From Turbine Exhaust	6,900
Consumption	6,900
Condensate Production Lbs/Hr	104,700
Boiler Feed Water Lbs/Hr	141,000
Cooling Water 85° F, GPM	
Process	12,000
Condensers	7,000
	19,000
Electric KW	
Process Units	530
Offsites	1,270
	1,800

TABLE 3—132,500,000 Lbs/Yr Ethylene Unit at 50,000-BPSD Refinery

Catalysts and Chemicals

	Inventory	Consumption (Lbs/CD)
Caustic	.....	2,700
Desiccant	93,000	127 (1)
Acetylene Hydrogenation Catalyst	50,000	69 (1)
Gasoline Hydrogenation Catalyst	14,000	19 (1)
Methanol	.....	1 bbl. (stream day)

(1) Estimated 2 year life.

THE ETHYLENE UNIT

Figure 2 shows the block flow diagram for the ethylene unit. The refinery products taken as feeds are the refinery gases, the propane LPG and the light straight run naphtha. Ethane recovered from refinery gas together with any produced in pyrolysis, is recycled and cracked to extinction. The PP product from both the refinery and ethylene unit is sent to the cat poly unit where the propylene is converted to polymer gasoline. Propane, which passes through the polymerization unit, is thus returned to the ethylene unit and cracked to extinction. Platinum reformer off gas is scrubbed with light straight run for hydrocarbon recovery prior to utilization as a source of hydrogen in the gasoline hydrogenation unit. Only a small amount of the hydrogen is consumed leaving the remainder available for other treating units, if required. Effluents from the cracking of ethane, propane and light straight run are combined with the refinery gas for purification, acetylenes removal and drying. The fractionation plant separates:

1. A tail gas product which can be partially utilized as fuel within the unit
2. the ethylene
3. ethane which is recycled to pyrolysis
4. propylene and propane (PP product) which is recycled to the refinery
5. A C_4 to 400 end point product which is treated in the hydrogenation unit in order to saturate the gum forming diolefin compounds. This material is then blended into the refinery gasoline pool
6. a small amount of fuel oil.

Material Balance. Table 1 presents the material balance for the ethylene unit. A total of 132,500,000 pounds per year of polymerization grade ethylene is produced, after allowance for fractionation and other losses. This rate is based on 330 stream days per year. The product yields from light naphtha pyrolysis are markedly affected by its chemical composition,[3] and this must be predetermined in order to assess the overall refinery yields. The conversion level can also be varied to change product distribution. A relatively high conversion level is used in this study since byproducts are a secondary consideration.

Utilities, Catalyst and Chemicals. The utilities balance for the ethylene unit is given in Table 2. Steam produced in the pyrolysis effluent quench boilers and in the pyrolysis furnace convection sections is used for the major compressor drivers and process requirements, thereby keeping the unit in steam balance. Offsite utilities (principally cooling tower power) are also included in this summary. Catalyst and chemicals consumption for the unit are given in Table 3.

Total investment for the ethylene facilities is $8 million including $500,000 for offsites and minor refinery unit revisions, as illustrated in Table 4.

Direct operating costs are tabulated in Table 5. In this tabulation fuel cost is purposely omitted and instead

TABLE 4—132,500,000 Lbs/Yr Ethylene Unit at 50,000-BPSD Refinery

Investment	
Process Units	$7,500,000
Offsites (cooling tower, storage, boiler feed treating)	500,000
Total Investment	$8,000,000

TABLE 5—132,500,000 Lbs/Yr Ethylene Unit at 50,000-BPSD Refinery

DIRECT OPERATING COSTS
(Dollars Per Calendar Day)

Utilities[1]	
Power @ 0.7¢/KWH	303
Chemicals and Catalysts	
Caustic @ 5¢/lb.	135
Desiccant @ 15¢/lb.	19
Acetylene Hydrogenation Catalyst @ $1/lb.	69
Gasoline Hydrogenation Catalyst @ $2/lb.	38
Methanol @ 8¢/lb.	20
Total	281
Labor[2] (7 men/shift) @ $3.50/hr.	588
Supervision @ 10% of Labor	59
Total	647
Total Direct Daily Operating Costs	1,231
¢/lbC$_2$-	0.34[3]

[1] Fuel is considered part of the refinery net product balance and is not shown here.
[2] Includes 1 man for offsites.
[3] At Gulf Coast power rates (0.5¢/KWH) cost will be 0.31¢/Lb.C$_2$-.

TABLE 6—Comparison of Refinery Gasoline Pool With and Without Ethylene Mfr.

Case	Refinery Only	Refinery + Ethylene Mfr.	
Nat. Gaso. Purch	No	No	Yes
Component	BPSD		
n Butane	2,706	2,337	2,215
B-B from C$_2$-MFR	.....	566	566
Nat. Gaso.	.....	.....	1,708
Lt. Strt. Run	3,200	.....	.....
Pyrolysis Gaso.	.....	627	627
Reformate	7,963	7,963	7,963
Cat Crkd.	8,895	8,895	8,895
Alkylate	2,198	2,198	2,198
Polymer	763	1,553	1,553
Total	25,725	24,139	25,725
TEL REQ'T* MI/G	1.80	0.81	1.05
L/SD	1,945	821	1,134

* To produce a 30% premium of 99 RON & 70% Regular of 93.5 RON.

fuel is calculated as a net refinery product. This is done to represent normal practice in which refinery produced fuel will be used in preference to purchased fuel.

BALANCES AND ECONOMICS

Gasoline Pool. Table 6 compares the refinery gasoline pool before and after the addition of ethylene facilities. In the base case (no natural gasoline purchase) a small net increase in butane requirements for vapor pressuring, due to removal of the volatile light straight run component from the pool, is more than offset by the B-B product from the ethylene unit resulting in a net decrease in butane purchase requirement. This B-B portion of the gasoline product, while rich in butylene, is not used as alkylation feed in this study although this might prove attractive. The replacement of low octane light straight run in the pool by a lesser quantity of higher octane pyrolysis gasoline (99.2 F-1 cl.) results in a considerable decrease in TEL requirements.

Butane. If natural gasoline is purchased to restore gasoline production to its pre-ethylene level, the C_4 purchase requirement is reduced further, but there is a net increase in TEL requirement over the base case due to the low octane number of this material.

Plant Balance. Table 7 summarizes the effects of the addition of ethylene facilities on the over-all plant material balance. The two cases considered are a base case with no purchase of additional feed stock, and an alternate which considers purchase of natural gasoline to maintain the original gasoline production level. As discussed previously there is a significant decrease in both of these instances in the requirements for purchase of normal butane.

Polymer. In both cases the propane LPG product is eliminated. All propane is recycled to extinction and all of the propylene is converted to polymer gasoline. It has been assumed that there is sufficient standby capacity in the polymerization unit to produce this polymer. This excess capacity is assumed to have resulted from the addition of alkylation facilities during the last few years. If this capacity were non-existent, propylene could be marketed as LPG and additional natural gasoline purchased to make-up the gasoline pool.

Fuel Balance. The ethylene plant, on balance, produces about as much fuel as it consumes as feedstock, since the refinery gas and reformer gas were formerly utilized as fuel in the refinery. However, its furnace fuel requirement markedly reduces the fuel gas available to the refinery and this deficiency is made up by vacuum tar causing a reduction in residual fuel oil production, and a small increase in distillate fuel oil because of decreased cutter stock requirements. The use of vacuum tar as refinery fuel is justified even on the basis of natural gas available at 20¢/million Btu's because of the value of the cutter stock required for blending.

Net Income. These refinery balance changes result in the net income increments summarized in Table 8. These data are for cases both with and without natural gasoline purchase, and for prices based on both Group 3 shipments and Gulf Coast cargoes. With the exception of LPG and natural gasoline these are recent posted prices. LPG and natural gasoline prices were obtained from trade quotations. TEL has been considered a feedstock in this table since its net changes reflect the qualities of materials leaving and entering the gasoline pool.

TABLE 7—Over-all Plant Material Balances With and Without Ethylene Mfr.

Case	Refinery Only	Refinery + Ethylene Mfr.	
Nat. Gaso. Purch.	No	No	Yes
Inputs			
Crude, BPSD	50,000	50,000	50,000
Nat. Gaso., BPSD	.....	.....	1,708
n Butane, BPSD	1,765	1,396	1,274
Products			
Gasoline, BPSD	25,725	24,139	25,725
C$_3$ LPG, BPSD	1,017	.....	.....
Kero. & Jet Fuel, BPSD	6,400	6,400	6,400
Dist. F.O., BPSD	9,834	10,101	10,101
Resid. F.O., BPSD	6,425	5,567	5,567
Ethylene, M#/SD	.....	402	402
Plant Fuel, BPSD (FOE)	2,880	3,988	3,988

TABLE 8—EFFECTIVE ETHYLENE FEEDSTOCK COSTS[1] (Net Change in Refinery Margin Due to Ethylene Production)

132,500,000 lb/yr Ethylene Production at a 50,000-BPSD Refinery

CASE			NO NATURAL GASO. PURCHASE			WITH NATURAL GASO. PURCHASE		
Pricing Basis	Group 3 Unit Price	Gulf Coast Unit Price	Quant.[2]	Group 3 $/SD	Gulf Coast $/SD	Quant.[2]	Group 3 $/SD	Gulf Coast $/SD
1. Inputs								
n Butane, B/SD	$1.89/B	$2.10/B	— 369	— 697	— 775	— 491	— 928	—1,031
Nat. Gaso., B/SD	$3.04/B	$3.36/B	.....	.....	.....	+1,708	+5,192	5,739
TEL, L/SD	$2.13/L	$2.13/L	—1,124	— 2,394	— 2,394	— 811	—1,727	—1,727
TOTAL INPUT CHANGE $/SD				— 3,091	— 3,169		+2,537	+2,981
2. Products								
Gasoline, B/SD	$5.74/B	$4.94/B	—1,586	— 9,104	— 7,835	.....	.....	.....
C_3 LPG, B/SD	$1.68/B	$1.89/B	—1,017	— 1,709	— 1,922	—1,017	—1,709	—1,922
Dist. F.O., B/SD	$3.98/B	$3.98/B	+ 267	+ 1,063	+ 1,063	+ 267	+1,063	+1,063
Resid. F.O., B/SD	$1.80/B	$2.30/B	— 858	— 1,544	— 1,973	— 858	—1,544	—1,973
TOTAL PRODUCT CHANGE $/SD				—11,294	—10,667		—2,190	—2,832
Net Feed Cost $/SD[1]	.....	.....	.....	8,203	7,498	.....	4,727	5,813
Net Feed Cost ¢/#C_2[1]	.....	.....	.....	2.04	1.87	.....	1.18	1.45

[1] Includes product changes resulting from ethylene plant fuel consumption.
[2] Net change in feed or product make over base refinery.

Incremental Costs. Only the incremental product realizations and losses are considered in these comparisons, and these are expressed both as $/SD and ¢/lb. of ethylene. This latter figure can be viewed as the effective feed cost for ethylene manufacture with all byproducts referred back to their values in refinery streams. These net feed costs include the fuel consumption in the ethylene unit since in the refinery balance the production of residual fuel oil has been varied to balance plant fuel requirements.

Net Feed Cost. In the base situation the net feed costs for the two areas are very close with a slight edge going to the Gulf Coast situation. This difference of 0.17¢/lb. while small results in a gross income differential of 225,000/yr. if ethylene is sold at the same price in both locations. It is immediately apparent that natural gasoline purchase is attractive at either Group 3 or Gulf Coast prices. This is particularly the case using Group 3 prices since this area has higher gasoline and lower natural gasoline prices than the Gulf Coast. This results in a feed cost advantage for the Mid-Continent area of 0.27/¢Lb. of ethylene ($358,000/yr.)

Obviously net feed cost and in particular the regional differences between these costs are very sensitive to variations in refinery product prices. Since these prices are subject to seasonal fluctuations, and will vary from refiner to refiner, the data presented here should be considered mainly as a guide in determining the attractiveness of a specific situation.

TABLE 9—Ethylene Manufacturing Costs

CASE	NO NAT. GASO. PURCHASE		WITH NAT. GASO. PURCHASE	
Pricing Basis	Group 3	Gulf Coast	Group 3	Gulf Coast
	¢/#	¢/#	¢/#	¢/#
Net Feed Cost[1]	2.04	1.87	1.18	1.45
Direct Oper. Cost[2]	0.34	0.31	0.34	0.31
Indirect Costs[3]	1.27	1.27	1.27	1.27
TOTAL MFG. COST ¢/#	3.65	3.45	2.79	3.03

[1] From Table 8
[2] From Table 5.
[3] Based on: Maint. @ 4% of Invest.
Tax & Ins. @ 2% of Invest.
Int. @ 3% of Invest.
Deprec. @ 10% of Invest.
Ovhd. @ 80@ of Labor + Supv

Flexible Charge Stock. In meeting a fluctuating market, the refiner can take advantage of the ability of the ethylene pyrolysis system to vary its charge stock from season to season. In the summer it would be practical, and indeed may be very advantageous, to buy open market LPG at a seasonally low price, blending the light straight run naphtha to gasoline when gasoline prices and demand are usually high. On the other hand, during the winter the refiner may wish to market LPG at a premium, while buying natural gasoline to make up the deficit in pyrolysis charge.

Total manufacturing costs of ethylene in the two areas is summarized in Table 9. The only significant case to case variation results from the feed cost differences previously discussed. In line with recent trends[4] no investment or labor cost differentials have been applied between the areas compared. These costs do not include consideration of return on investment, but with the current selling price of ethylene reported at about 5 cents a pound it is apparent that any of these situations could be attractive.

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Key Words for Indexing

Catalysts, Chemicals, Costs, Economics, Ethylene, Feeds, Fuels, Investments, Material Balances, Petroleum, Products, Propane, Refining, Utilities

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Remote Control Cuts Tank Farm Costs

The remotely controlled functions are: tank gaging, pump and valve motor control, pump discharge pressure indication, alarm, and over-ride tank level controllers

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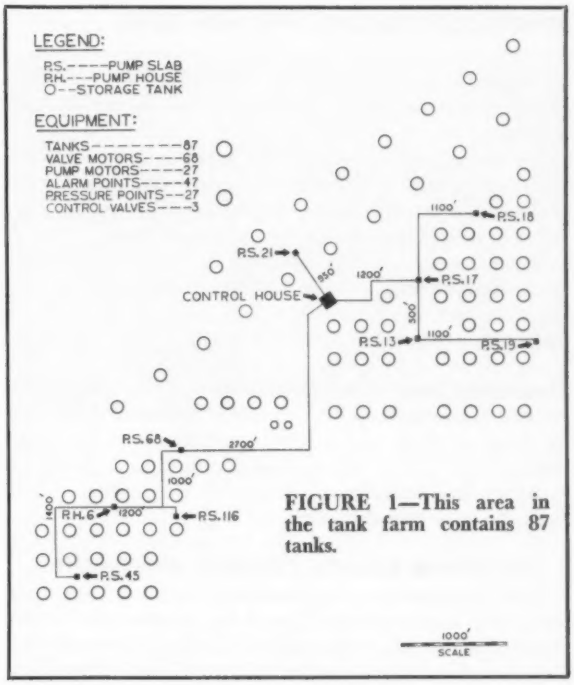

FIGURE 1—This area in the tank farm contains 87 tanks.

In the past two or three years, considerable work has been done in Humble's Baytown, Texas, refinery to improve the efficiency of tank farm operations. As one step toward that goal, the tank farms have been divided into six operating areas with one centrally located control house in each area. The size of these areas and the amount of equipment is such that centralized control with reduced manpower is not practical except by the use of so-called remote control facilities. There are approximately 700 tanks and 60 pump slabs in this category located within an area of approximately 3,000 acres. The tanks within process unit limits are not included.

Typical Operating Area. Figure 1 shows the size of the consolidated operating areas and the amount of equipment suitable for remote control. This is a plan of Area 1 which consists of approximately 250 acres containing 87 tanks, 9 pump slabs with 27 motor-driven pumps, 68 motor-operated valves, and related equipment. The distances between the control house and the pump slabs range from 950 feet to Pump Slab 21 to approximately 6,300 feet to Pump Slab 45 via existing pole lines. In addition to the equipment at the five pump slabs, there are motor-operated valves in the pipeline alleys and at some tanks, level control valves in tank fill lines, tank level alarms, etc., to be controlled throughout the area.

FUNCTIONS TO BE PERFORMED REMOTELY

Remote Tank Gaging. The remote gaging of tanks is essential for the application of centralized control for large refinery tank farms.

Pump Motor Control. Start and stop control and continuous running light indication is needed for pump motors. Most motor-driven pumps, 75 horsepower and above, operate on 2,300 volts and up to 75 horsepower on 440 volts. All are induction motors and are started with across-the-line oil-immersed starting equipment. The 440-volt starters are in individual explosion-proof housings. The 2,300-volt starters are in individual tank-type enclosures with all arcing contacts immersed under at least six inches of oil. Each starter is located near the motor that it controls.

Valve Motor Control. Open, close, and stop control and continuous two-light indication of valve position is used for each electric motor-operated valve. The newer valve operators have three-phase, 440-volt motor drivers, a reversing starter mounted inside the limit switch compartment, and 110-volt controls. Some of the older operators utilize starters in separate housings located remotely from the valves.

Pump Discharge Pressure Indication. The discharge pressure of each pump that is being operated remotely should be continuously indicated at the central control house. Most tank farm pumps at Baytown operate against relatively low heads, so that maximum discharge pressures seldom exceed 200 psi.

Alarms. The only alarm points that have been installed in these remotely controlled tank farms are for low pump discharge pressures and selected tank levels. The low pump discharge pressure alarms are to alert the operator in case a pump inadvertently shuts down, a pipe ruptures, or the mechanical seals in a pump fail in service. Some tanks are grouped so that several of different heights are operated in parallel from a common header system. Automatic operating valves are installed to close the fill line to each of the low tanks and allow the taller tanks of a particular group to be filled

to capacity. Level alarms are needed to warn the operator if the automatic operating valves do not operate properly.

Vibration and bearing temperature relays were considered for some of the remotely controlled pumps with an attendant alarm to warn the operator in case of bearing failures. However, when the high cost of these safety features was compared with the value of the small size pump motors (all are under 600 horsepower) the decision was made to leave off these devices unless operating experiences showed a definite need for them.

Over-ride Tank Level Controllers. Electro-hydraulic control valves with manual override are installed in the fill lines of three tanks. Level controllers on the tanks position the valves, but an override feature is provided to allow the operator to manually close these valves from the panelboard.

SELECTING REMOTE CONTROL EQUIPMENT

The equipment to be controlled is in a hazardous area, it is widely dispersed, and the distances from the control points are within relatively short distances. At Baytown, these distances do not exceed two miles. The operating people prefer that the control point of a tank farm remote control system consist of a semigraphic panelboard with indicating lights and alarms to continuously monitor the operating equipment. The pressure and tank level transmitting and indicating equipment were selected from standard available market items. The remote control equipment for valve and pump motors and the alarm systems were developed by a local company for this application.

Maintenance. It is desirable to have equipment installed that requires little or no scheduled maintenance, such as the cleaning or relay contacts, the replacement of electronic tubes, etc. In the event that trouble does occur, time and money are saved if the equipment can be serviced with minimum effort. Factors which contribute to easy maintenance are plug-in components and simplified circuitry with a minimum number of parts.

Maintenance work on electrical equipment is normally performed by the regular refinery electricians. Each man is assigned to a given work area on a rotational basis to broaden his knowledge of and experience with the multiplicity of different kinds and variations of electrical eqipment in the refinery. There are approximately 100 electricians employed in the refinery and at a given time almost any one of these men might be called upon to perform work on remote control equipment. It is not practical to give each man simultaneous specialized training on each type of refinery electrical equipment. Therefore, it is advantageous to install equipment that requires a minimum of special training for maintenance personnel.

Explosion-Proof Equipment. It is common practice to consider that the area within a tank farm where volatile liquids or gases are stored is classified either Class I, Group D, Division 1 or Division 2. This dictates the need for explosion-proof equipment to conform with these classfications. Air-purged equipment is not practical for tank farms because of the lack of a dependable air supply in these areas. In view of the above, the field equipment of a remote control system should be flexible enough so that it can be economically installed in explosion-proof housings. Three of the tank farm control houses are classified Class I, Group D, Division 2 so that all the equipment installed in the control panels in these areas must conform to the Division 2 classification.

Transmission Wires. Another important consideration is the number and type of transmission wires required both in the secondary cable system from the remote control field units to the individual pieces of equipment being controlled, and in the primary cable system back to the panelboard at the central control point. When the distances from the control house to the field equipment are relatively short, or within one or two miles, the incentive for limiting the primary cable system to a pair of wires versus installing a multiconductor cable is not as great as it would be if the control house were ten to twenty miles from the tank farm.

Corrosion Resistance. Corrosion of field components is a major problem in the Gulf Coast area unless they are mounted inside a heated enclosure, made of corrosion resistant alloys, are hermetically sealed, or immersed in oil.

DESCRIPTION OF EQUIPMENT

The equipment consists of cubicle-type, semigraphic panelboards containing all the control point equipment mounted and wired to terminals, and miscellaneous field equipment for installation near the equipment to be controlled.

The general term remote control equipment can be separated into four different classes of equipment: (1) pressure transmitting and indicating equipment, (2) alarm and controller override equipment, (3) control equipment for valve and pump motors, and (4) tank gaging equipment.

Pressure Transmitter. A combination pressure transducer and electronic transmitter unit was selected for the operating areas. The field unit is small, compact, and is available in an explosion-proof housing at nominal cost. A separate transmitter unit is installed for each pump discharge pressure indicated on the control panel. Figure 2 is a typical field installation of a pressure transmitter and a pressure switch for alarm actuation. A pressure indicator is installed for each transmitter. The pressure indicators are DC milliammeters with scales calibrated to indicate pressure in psi. One No. 22 gage non-shielded wire with common return is provided between each transmitter and the control panel. The equipment can be operated through the same multiconductor cable system as the other remote control equipment.

Alarms. The alarm equipment is similar to annunciator systems already in general refinery use at Baytown. The alarm relays are hermetically sealed and are the plug-in type. The main variations from a standard

system are that sensitive relays and a 50-volt DC power supply are used to obtain a system suitable for operation over a No. 22 gage wire with common return. Standard pressure and level switches in explosion-proof housings provide normally closed field contacts for fail-safe operation. A single alarm light for indicating an abnormal condition is installed in the graphic panelboard adjacent the corresponding symbol for the equipment that is being monitored in the field. The light is off when the operation is normal, comes on flashing accompanied by a buzzer when the condition becomes abnormal, remains on steady and the buzzer is silenced when the acknowledge pushbutton is actuated, and goes out when the condition returns to normal. A full operational test button is provided for testing lights and relays.

Control Valve Override Equipment. The override circuit used to provide for manual closing of each of the automatic tank level control valves is a three-pole relay that can be operated by closing a maintained contact pushbutton on the panelboard. The relay contacts are connected so that when power is removed from the relay coil the contacts open to break the circuit from the level controller transmitter to the control valve, thereby causing the valve to close. A light inside the override pushbutton on the panelboard is actuated by one of the override relay contacts and indicates to the operator that the control circuit to the valve is open.

Remote Control Equipment for Valves and Pumps. The equipment was designed to provide a simple individual control system for each pump and motor-operated valve. Each system operates though a pair of telephone wires or through one wire with a common return wire for a group of systems. For example, the complete system for a single motor-operated valve consists of a control unit, a field unit, and a connecting single wire transmission line with common return. By utilizing the principles of partial rectification and alternating current, it is possible to operate a valve from distances up to ten miles over a No. 22 gage telephone wire. The valve can be opened, closed, or stopped in any intermediate position with two lights at the control point to indicate valve position. A pump can be started or stopped and continuously monitored with a running light on the panelboard. The individual control systems are then used as building blocks to make up a complete system for controlling several pieces of equipment from the same location.

A combination demonstration and test unit was purchased that contains a model motor-operated valve and the actual components required for controlling a valve from a remote location. The control end equipment consists of a power supply; a small chassis with two hermetically sealed plug-in relays, two plug-in rectifiers, terminal strips, and a plug-in can containing capacitors; and three pushbuttons and two indicating lights. The field equipment consists of a chassis containing two relays, two capacitors, and two rectifiers.

This model system was purchased chiefly as a demonstration unit but has proven invaluable as a testing unit for the remote control equipment installed in the field. Not only can the control point chassis on the model be used to operate any single remote control field unit but the field end unit and model valve can be operated with any control end chassis in the panelboard by making the proper wiring connections. In addition, the model can be used to test suspect relays, diodes, and capacitors by substituting them for known good components in the model. An appreciable amount of installation labor is saved by using the control end chassis and control station on the demonstration unit to operate each motor-operated valve and pump through the individual remote control field units as soon as all the wiring connections are made. Then any errors or difficulties can be corrected before the field equipment is connected to the overhead cable system.

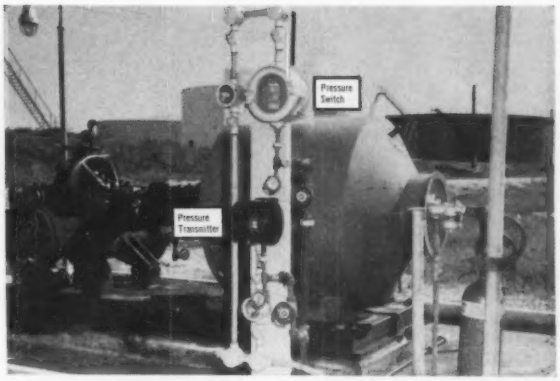

FIGURE 2—Typical field installation of pressure transmitter and pressure alarm switch.

In the controller used for remote control and indication of a motor-operated valve, two relays provide contacts for actuation of the valve operator pushbutton station. One of the relays, designated valve opening, is energized to close a pair of contacts which are wired in parallel with the "open" pushbutton, causing the valve to start opening. The other relay, marked valve closing, is energized to close a pair of contacts in parallel with the "close" pushbutton, causing the valve to start closing. If both relays are energized simultaneously, a separate pair of contacts are opened. These contacts are wired in series with the "stop" pushbutton, causing the valve to stop. The limit switches required to give remote indication of the valve position are wired in series with the two relays in the field unit and the indicating light relays in the control house. The pilot light relay does not permit the field relay to pick up when the two are connected in series. These limit switches are normally closed, and open only at the extreme ends of travel of the valves. When either of these switches opens (valve either fully open or fully closed) a circuit to the control point is interrupted, causing one of the indicating light relays to drop out and give the corresponding indication of valve position. The operation of the pilot lights is such that with the valve in any intermediate position between open and closed, both pilot lights are on. When the valve reaches the fully opened position, opening the upper limit switch, the "closed" pilot light goes off; similarly, when the valve is fully closed, the "open" pilot light goes off. Three pushbutton switches on the control panel are used for control of the relays in the

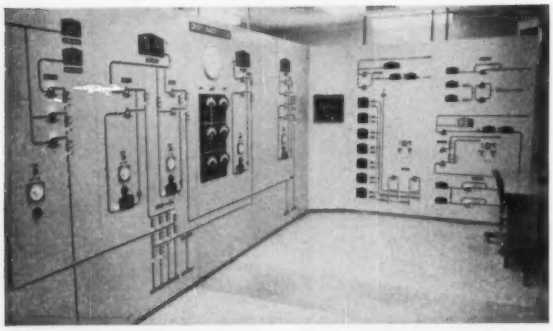

FIGURE 3—Cubicle type semigraphic control panel for one tank farm area.

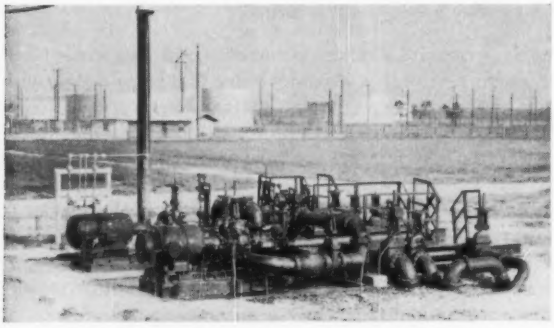

FIGURE 4—Typical pump slab for remote control.

field unit: one switch actuating one relay to provide the "close" operation, one switch actuating the other relay to provide the "open" operation, and the other switch actuating both relays to provide the "stop" operation. The following voltages are used to perform the given operations:

OPEN—half wave rectified AC, positive
CLOSE—half wave rectified AC, negative
STOP—60 cycle AC

The system for operating a pump is essentially the same as that for a valve except that only one relay is needed at the control end for the pump running light. The remote control field chassis for a pump is exactly the same as for a valve. The field wiring required between the local control equipment and the remote control field unit for a valve or pump motor is relatively simple. Basically, the field unit provides the necessary contacts to parallel the local open and close pushbuttons and series the stop pushbutton. The remote indicating lights can be operated by the same limit switches that control the local lights by using interposing relays. It is usually more economical to provide separate limit switches for the remote lights as was done in this installation.

The operation of a controller used for remote control and indication of a pump is essentially the same as that for a valve controller, with one relay providing contacts for stopping the pump and the other relay providing contacts for starting the pump. Only one indication switch is necesary—normally open contacts which are closed only when the pump is running. At the control point only one relay is used with its contacts operating the "on" pilot light. Two pushbutton switches on the control panel provide operation of the two relays in the field unit, one switch for "start" and one for "stop." The voltages used for the pump controller are as follows:

START—half wave rectified AC, negative
STOP—half wave rectified AC, positive

Overhead Cable System. A common cable system is installed to connect all the remote control field equipment to the control point equipment inside the panelboard. The cable is polyethylene-insulated telephone cable with No. 22 gage solid copper conductors, an over-all shield, and a PVC jacket. It was selected because of its low first cost, good quality, and availability from local stocks. The cable is installed on a 3/8-inch galvanized steel messenger with stainless steel spinning wire except in very corrosive areas. In areas where the atmosphere is especially corrosive, stainless steel messenger cables are used for supporting the remote control cables. Strand-mounted protected terminals are used to connect from the field equipment to the overhead cable system. These were selected because of their rugged construction, flexibility, or ease by which terminals can be added anywhere along the cable, and protection afforded against damage to the remote control equipment from lightning surges.

Remote Tank Gaging Equipment. Of the 700 tanks in the refinery that are suitable for remote gaging, 425 have been equipped with remote reading gages. Work is in progress on 25 more which will bring the total to 450 during the first quarter of 1961.

There are three different kinds of remote tank gaging equipment operating in the refinery. Electronic gages were the first installed but more recent installations have been the newer pulse-type models that are now available.

REMOTE CONTROL EQUIPMENT

Panelboard. Figure 3 shows the semigraphic panelboard from which centralized control of Area 1 tank farm is performed. The panel is made up by bolting together individual free-standing cubicles four feet wide

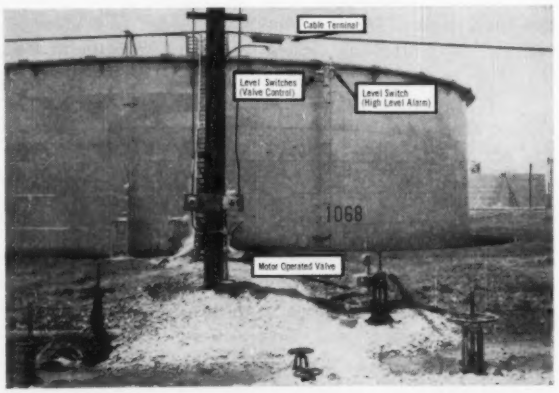

FIGURE 5—Motor-operated valve in tank fill line is controlled by tank level switches.

by eight feet high by two feet deep with hinged access doors in the back. The cubicles are fabricated of No. 11 gage steel with two by two by ¼ angle framework. The panel front is ¼-inch Fibreboard diestock with a light green laminated plastic facing. The lines and symbols are aluminum and are bolted to the front of the panel.

The fronts of other panelboards have been fabricated from ¾-inch thick Fibreboard diestock or from ¼-inch thick aluminum with laminated plastic facings in order to increase the rigidity and eliminate the tendency of the ¼-inch Fibreboard to warp.

Each panel section was purchased with factory installed remote control equipment for performing the functions indicated by the graphic picture on the front wired to terminals in a wireway at the top. Each of the sections for the remote control system is electrically independent of the other sections. There are separate power supplies, separate alarm systems, testing switches, and related equipment so that one section can be taken out of service without affecting the operation of the others.

The "open-stop-close" pushbuttons and pilot lights for each motor-operated valve are located adjacent the corresponding valve symbol in the graphic picture. The "start-stop" pushbuttons for the pumps are mounted on each side of the pump symbols. The red light in the center of each pump symbol is the running light and the amber light above each pump symbol is the low-discharge alarm light.

Test switches are provided in each section for testing all the remote control components in the panelboard except the pressure transmitters. An alarm test switch can be actuated to provide the same action as if all field alarm conditions had occurred, thus testing the relays, lights, flasher, and buzzer. A controller test switch is provided for operating all the relays and indicating lights in the valve and pump controllers in the panelboard. This testing does not apply to the field units.

Ground detectors are provided for detecting grounds in the equipment or the interconnecting cable system. An "off-on" switch is spring loaded to the "off" position. During operation, this switch is held "on" while a meter reading is made, then with the switch still "on" the polarity switch is changed from plus to minus and another reading taken. If a current is detected in either position, a ground is indicated and should be cleared up.

There are two doors in the back of each four-foot wide panel section and one door in the back of the two-foot wide section.

The equipment for each alarm point and pump and valve controller is mounted on an individual chassis that is clearly marked as to its function and the individual piece of equipment that it controls. The pushbuttons and lights on the panel are labeled on the front and back of the panel. There is an eight-inch by eight-inch wireway at the top that extends the full length of the panelboard. Space was provided for installing future equipment in each section. The installation of the panel was relatively simple because the only field wiring necessary was the connection of 110-volt power leads and the incoming remote-control cable to terminal strips in the wireway at the top.

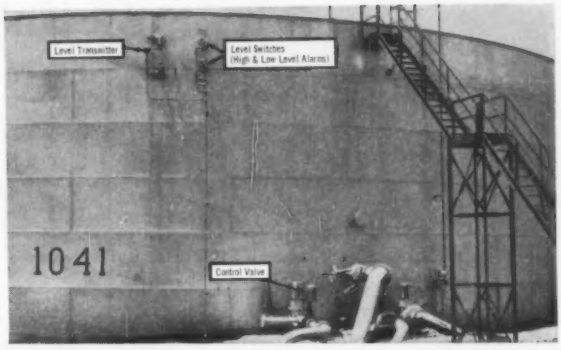

FIGURE 6—Electro-hydraulic control valve in tank fill line with level controller and alarm switch.

FIGURE 7—Overhead circuits and remote control equipment service these two motor operated valves.

Field Equipment. Typical pump slabs that are being controlled remotely are shown in Figure 4. The number of pumps per slab range from one to ten. Some of the remote control field equipment is visible at each location. The valve or pump controller housing is explosion-proof and measures approximately six inches by eight inches. There are two plug-in relays and one plug-in composite component can.

Since the original installation of this type remote control equipment, considerable work has been done toward reducing installation costs. As one step toward reducing costs, field units have been grouped in a sheet metal enclosure for Division 2 areas where several are needed at the same place.

As a further step toward reducing installation costs, motor-operated valves are purchased with remote con-

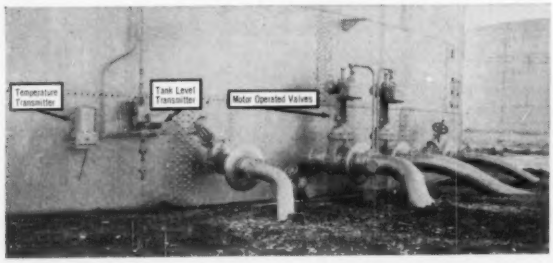

FIGURE 8—Motor valves, tank level and temperature transmitters make up a typical tank installation.

trol field units factory installed in the operator housings along with the local pushbuttons and pilot lights.

Figure 5 shows a motor-operated valve in a tank fill line controlled by level switches on the tank. One of the three tank level switches shown actuates a high level alarm in the control house. The overhead control cable, the cable terminal and the tank level transmitter are also visible. A selector switch is installed at the valve to provide for changing from automatic to manual operation. This valve is located in the line alley between two tank firewalls. The only connections between this particular tank and the control panel are for the high level alarm and the tank level transmitter that can be seen just above the low platform on the side of the tank.

Figure 6 shows an electro-hydraulic control valve in a tank fill line. The level controller for the valve and two level switches for actuating high and low level alarms are installed near the top of the tank.

Figure 7 shows two motor-operated valves with the associated electrical service and remote control equipment. The 110-volt and the 440-volt overhead secondary circutis terminate at the power pole and the remote control cable is terminated in the strand-mounted terminal. One 110-volt circuit breaker and one 440-volt circuit breaker are installed at the base of the pole for the two valves. There is a remote control field unit with a disconnect switch for each valve. The local control stations for the valves are in explosion-proof housings and are mounted on the valve operator housing.

Another typical installation of tank farm equipment is shown in Figure 8. There are two motor-operated valves in the tank suction and fill lines, a tank level transmitter and a temperature transmitter. The valves are controlled from a local station at the tank firewall and also from the panelboard in the Area No. 1 control house. The remote control field units for the valves are installed in individual housings and are mounted on a switchrack at the firewall.

MAINTENANCE EXPERIENCE

Alarm and Override Equipment. No failures of any kind have occurred with the alarm or the override equipment except indicating light bulbs. Routine servicing is not required.

Remote Control Units for Valves and Pumps. The original installation of 50 valve and pump remote control units with 200 operating relays has been in operation for more than two years with only minor maintenance. There are no parts that require any periodic servicing except for the replacement of light bulbs on the panelboard. All the relays are hermetically sealed, and their contacts are rated to carry over ten times the normal operating currents as are the rectifiers and the pushbuttons. This original equipment was furnished by error with diodes that were not hermetically sealed and during the initial start-up it was necessary to replace approximately 10% because of excessive moisture absorption. These were replaced with sealed diodes.

The diodes used in later installations of this equipment are a new and improved hermetically sealed type that have given excellent service and no further difficulties are anticipated with diode failures.

Pressure Transmitters. Difficulties were experienced with the original electronic pressure transmitters. Field experience was so poor with these transmitters during the first year that they were replaced with transmitters of a different design. Field experience with the new transmitters has been very good.

Electro-Hydraulic Control Valves. Field experience with the electro-hydraulic control valves was poor when they were first installed. However, subsequent modifications to the hydraulic operator have significantly reduced maintenance requirements.

Remote Tank Gaging Equipment. The service factor of the electronic tank gaging equipment has been good for this type of equipment but there are inherent design features that necessitate more periodic calibrating and servicing than is required for pulse-type equipment. It is subject to errors due to damp or dirty terminals in field junction boxes, high resistance grounds on the electrical circuit, and any current leakage in the overhead cable system.

Pulse-type equipment has given excellent service.

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Key Words for Indexing

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Warren

Reboiler Selection Simplified

Too often, arbitary selections of reboiler type and feed systems are made without considering other process and economic possibilities

John K. Jacobs, Boston

Process engineers are frequently called upon to design reboiler systems. Here is an analysis of six reboiler feed systems together with the calculation check points required. No attempt is made to directly consider the mechanical, hydraulic or thermal design of the reboiler itself, or of the column internals.

Reboiler Feed Systems. In each of the six systems considered, "G" is the gross bottoms (bottom plate liquid overflow); "B" is the net bottoms (bottom product); "F" is the reboiler feed; "V" is the reboil vapor; and "L" is the unvaporized liquid from the reboiler. LC refers to the level controller, which regulates withdrawal of net bottoms.

The feed systems are of three kinds: net bottoms feed recirculating, gross bottoms feed once-through, and mixed bottoms feed recirculating. In the discussion of the various feed systems, particular emphasis will be placed on the design requirements of vertical thermosiphon reboilers, since these usually require special consideration.

Net Bottoms Reboiler Feed. Arrangements employing net bottoms feed are shown in Figures 1 and 2. These are the simplest of the feed systems and are particularly

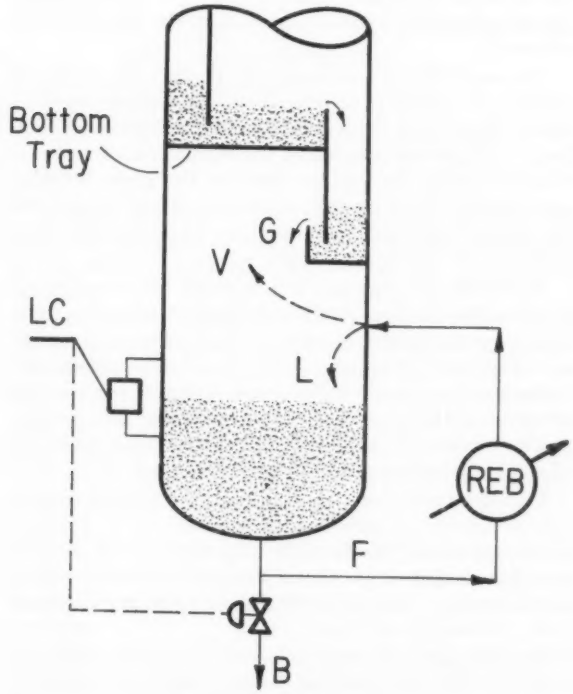

FIGURE 1—Unbaffled

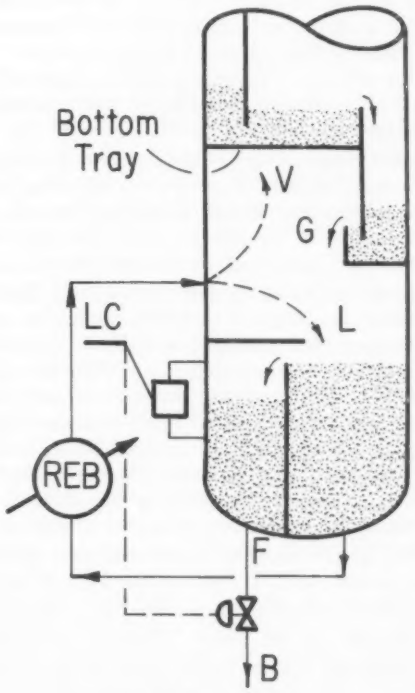

FIGURE 2—Baffled

NET BOTTOMS FEED SYSTEMS

ADVANTAGES

1. Simplicity
2. Good for small towers (unbaffled)
3. No collector tray required

DISADVANTAGES

1. Poor for thermal fouling
2. Sacrifices stripping plate
3. Lowest reboiler average Δt
4. Baffled system lacks simplicity
5. Unbaffled system has varying feed head
6. Unbaffled system has uneven net bottoms flow

advantageous in small towers. The unbaffled type completely avoids tower bottom internals. The baffled type is somewhat simpler than other recirculating feed arrangements. Net bottoms feed systems require no collector plate when used with packed towers or with plate towers employing trays without downcomers.

In thermal fouling service, the net bottoms feed arrangement should be generally avoided whenever the temperature rise is appreciable. A solution of two or more volatile components boils over a range of temperature, from the initial boiling temperature (bubble point) to the final temperature at which the last bit of liquid is vaporized (dew point). Thus, with net bottoms feed systems, the vapor and liquid leaving the reboiler must be heated to a temperature higher than that of the net bottoms. The temperature rise depends on the percent vaporization achieved in the reboiler and upon the net bottoms composition. When the net bottoms has a narrow boiling range, as in the case of an azeotrope or a high purity single component bottoms product, no significant temperature rise occurs in the reboiler. Temperature rise can be minimized by designing for high recirculation rate so as to reduce the percent vaporization to a low figure.

The temperature rise in the reboiler produces a lower temperature difference between the reboiler process fluid and the heating medium. It should be recognized, however, that a decrease in temperature difference is not always disadvantageous, since high temperature differences may produce film boiling and consequently lower heat flux than that obtainable at closer temperatures with nucleate boiling.

A further disadvantage of the net bottoms feed system is that it sacrifices part of one theoretical stripping plate, since the reboil vapor is not in equilibrium with the net bottoms but is in equilibrium with the reboiler exit liquid, which is heavier than the net bottoms.

Thermosiphon reboilers require a certain liquid level in the tower in order to maintain circulation through the exchanger. The throughput depends upon the hydrostatic driving force, which is the difference between the static head of clear liquid in the tower and the effective static head of the aerated fluids in the reboiler. The throughput attained is that for which the hydrostatic driving force is equal to the sum of the pressure drops in the circuit. Thus, fluctuations in liquid level in the tower may cause serious variations in reboiler throughput. This is particularly disadvantageous in vertical thermosiphons, which are generally mounted with a direct horizontal reboiler process fluid exit line from the upper channel to the tower. There is little allowable leeway from the normal liquid level, which is generally established in the vicinity of the upper tube sheet. Lowering the liquid level will strongly reduce recirculation, while raising the level will soon flood the process fluid exit line. Analysis of the response characteristics of the system, or previous experience, may indicate that a properly designed level control instrument may be capable of maintaining adequate control of liquid level variance. In this case the flow of net bottoms will probably be subject to severe fluctuation. When the net bottoms is fed directly to a downstream process unit this may be a serious disadvantage.

In general, for vertical thermosiphons it is preferable to insure a constant feedhead which can best be accomplished by installation of a weir as shown in Figure 2. However this sacrifices much of the simplicity which is the most attractive feature of the net bottoms feed system, while maintaining the disadvantages of high reboiler exit temperature and loss of a fraction of a stripping plate. In a tower with downcomer type trays there is little advantage to the baffled net bottoms feed arrangement over the generally preferable mixed bottoms feed system.

Gross Bottoms Reboiler Feed. Feed for a once-through reboiler is gross bottoms, delivered from a bottom tray trap-out as shown in Figures 3 and 4. The percent vaporization is an invariant function of the process since the total gross bottoms is the reboiler feed and the net bottoms is the total exit liquid. No liquid recirculates.

Once-through feed systems are particularly attractive for services where polymerization fouling is likely to occur, since repeated contacting of liquid with the hot tube wall is prevented and consequent cumulative growth of polymer is minimized. (In such services it is generally advisable to minimize residence time at net bottoms temperature by using a low liquid level in the bottom of the column.)

The once-through arrangement is often the preferred scheme for strippers or other low boil-up ratio applications. Since good thermosiphon design is generally limited to 30 percent maximum vaporization and since the trap-out limits the reboiler feed to the gross bottoms, once-through feed arrangements should not be selected for thermosiphon reboilers when the reboil vapor is more than 3/7 of the net bottoms.

Maximum temperature is that of the net bottoms and is generally reached at the exit, though with low pressure (especially vacuum) towers the maximum temperature may occur part way down in the tubes. Minimum temperature is that of the gross bottoms, so that the average temperature difference between the process fluids and the heating medium is larger than with any of the recirculating feed arrangements.

Packed columns or trays without downcomers require a collector tray, which may be a sieve tray in nonfouling applications, but is preferably a flat collector tray with one or more vapor risers. Frequently a manway can be avoided by using a vapor riser of sufficient diameter with a deflector disc above.

Feed piping is slightly more complex than with net bottoms feed arrangements. With a seal pan trap-out, the downcomer must project below the feed pipe to prevent vapor flow up the downcomer when the liquid level is down in the feed pipe.

With vertical thermosiphons, the upper tube sheet may be located well below the trap-out since liquid level control is far less important in nonrecirculating arrangements. Some fouling pressure drop may be offset by the ability of the liquid feed to build up in the feed pipe and downcomer.

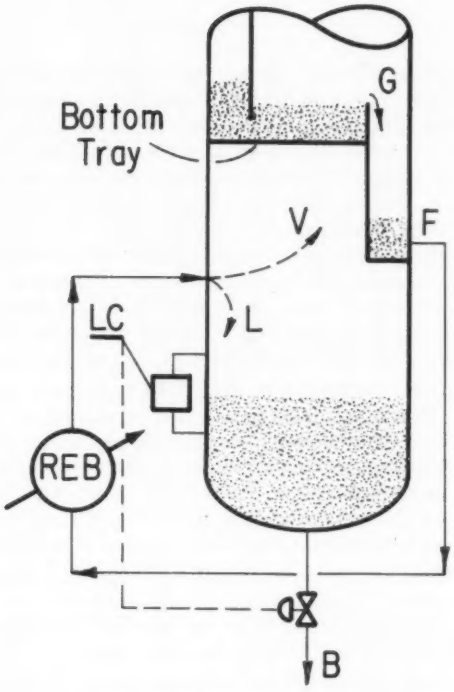

FIGURE 3—Positive Trap-Out

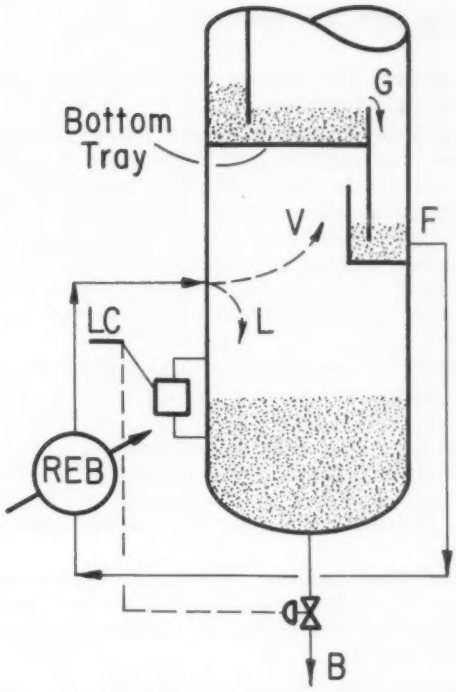

FIGURE 4—Seal Pan Trap-Out

GROSS BOTTOMS FEED SYSTEMS

ADVANTAGES	DISADVANTAGES
1. Best for polymer type fouling	1. Limited to once through operations
2. Best for reboiler average Δt	2. Limited to V/B of 3/7 with thermosiphons
3. Simple column internals	3. Needs collector tray if downcomer-less

In cases of stringent tower bottoms product specifications it is advisable to select a positive trap-out (Figure 3) in order to force all the gross bottoms through the reboiler.

The overflow of the downcomer seal in the seal pan type trap-out (Figure 4) is designed to permit operation in a badly fouled condition (presumably at higher reboiler operating temperature) or during temporary column upsets. However, tower surging, reboiler fouling, or column startup difficulties may cause seal overflow and thus dilute the net bottoms tower product with lighter gross bottoms material.

Mixed Bottoms Reboiler Feed. The mixed bottoms feed arrangements, as shown in Figures 5 and 6, are recirculating and use a feed mixture of net and gross bottoms.

This feed arrangement is reasonably satisfactory in most fouling sevices and is not limited to low boil-up ratios when used with thermosiphon reboilers, so that it is, perhaps, more widely applicable than other types.

The mixed bottoms feed arrangement has a maximum feed temperature equal to that of the net bottoms, but the average process temperature is intermediate between those of the net bottoms and the gross bottoms (once-through) feed arrangements. Thus, mixed bottoms feed reboilers are inferior to the once-through in average temperature difference between the fluids, although the more important minimum temperature difference is the same.

In thermal fouling of the insolubility type or of the type caused by a first order reaction (such as dehydrogenation or carbonization) the significant temperature is the maximum achieved. This temperature will generally be that of the film on the hot tube wall at the reboiler exit. In many cases the percent vaporization of a mixed bottoms feed reboiler is less than that of a once-through, so that the higher liquid flow should produce higher turbulence which may improve washing action on the tubes and produce a thinner film at the tube wall. Thus, in certain instances, the mixed bottoms feed arrangement may be as satisfactory in fouling services as the once-through. In thermal fouling services using a noncondensing heating fluid, it is often advisable to choose concurrent flow, if ample temperature difference is available between process and heating fluid outlets.

Recirculating feed arrangements should be avoided in severe polymer type thermal fouling.

A major disadvantage of mixed bottoms feed systems, particularly in small towers, is the complex baffling required. As in the once-through type, a downcomer-less is required so that towers using packing or proprietary trays require a collector tray which further adds to the complexity and maintenance difficulty.

Since variation in crest over the weir is negligible, reboil circulation rate is substantially unaffected by col-

umn surging. The constant reboiler feedhead is favorable for thermosiphons.

A possibility may exist that with certain combinations of flows, temperatures, and compositions of gross bottoms and reboiler exit liquids, some vaporization might occur in the downcomer from superheating of the downcomer liquid. Since both streams are saturated liquids at the same pressure, it is improbable that differences in enthalpies will be sufficient to produce appreciable vaporization. Extreme cases should be checked by heat balance.

Baffles may be horizontal or vertical and there is little to choose between them. In smaller columns the horizontal type (Figure 5) is generally superior where reasonably large net bottoms product flow and holdup times are required. It is also slightly preferable for small column maintenance. A small advantage of the vertical baffle (Figure 6) is in slightly simpler feed piping.

Vertical Thermosiphon Reboilers. Vertical thermosiphons (Figure 7) are generally the cheapest, easiest to support, most readily cleaned, and most compact of reboiler types.

Thermosiphons are sometimes regarded with a certain skepticism based on unfortunate experiences with misapplications and improper design. Typical errors include designs based on excessive vaporization (particularly with once-through feeds), designs based on over-all transfer coefficients rather than fluxes, and use of excessive temperature differences that result in film rather than nucleate boiling. The hydraulics are not simple, particularly in vacuum installations, and such items as the expansion pressure drop from vaporization should not be overlooked. However, properly designed thermosiphons in applicable services may be specified with confidence. Poorly designed thermosiphons tend to produce intermittent bursts of vapor. In some cases this condition may be improved by installation of an orifice at the exchanger shell outlet to increase vapor pressure drop.

Vertical thermosiphons are generally hung on the tower, thus minimizing foundation, structural, and plot area requirements. Not more than three parallel vertical thermosiphons should be installed on a single tower. Most thermosiphons use 8-foot tubes. Even with 16-foot tubes not more than 10,000 to 12,000 sq ft of reboiler area can be used on a tower with vertical thermosiphons.

Vertical thermosiphons generally use an extremely short process fluid discharge line which directly connects the upper channel to the tower. This minimizes vapor pressure drop and vapor line costs.

Vertical thermosiphons have the process fluid in the tubes, which makes cleaning and normal maintenance simple. Since the heating medium is often a very clean fluid (such as steam) it may be possible to minimize re-

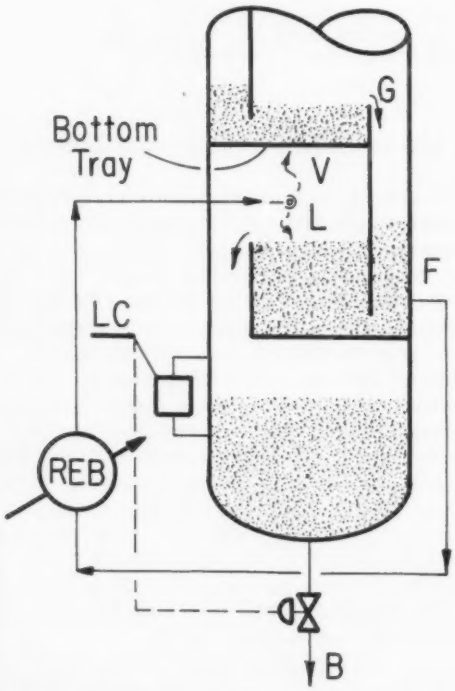

FIGURE 5—Horizontal Baffle

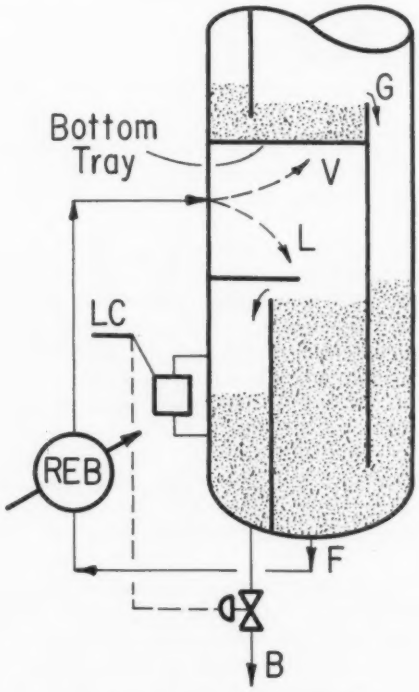

FIGURE 6—Vertical Baffle

MIXED BOTTOMS FEED SYSTEMS

ADVANTAGES	DISADVANTAGES
1. Satisfactory for most fouling services	1. Complex baffling in column
2. Most flexible system	2. Needs collector tray if downcomer-less
	3. Slightly inferior to gross bottoms feed in average Δt

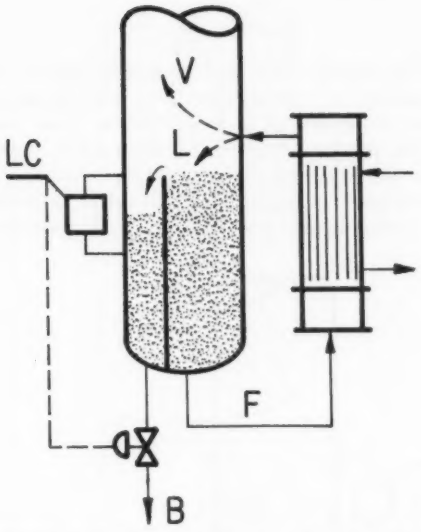

FIGURE 7—Vertical Thermosiphon Reboiler

ADVANTAGES	DISADVANTAGES
1. Cheap	1. Maximum reboil area limited
2. Easily supported	2. Requires fixed feed head
3. Compact	3. Limited to 30% or less vaporization
4. Easily cleaned	4. Circulation rate limited by hydraulics

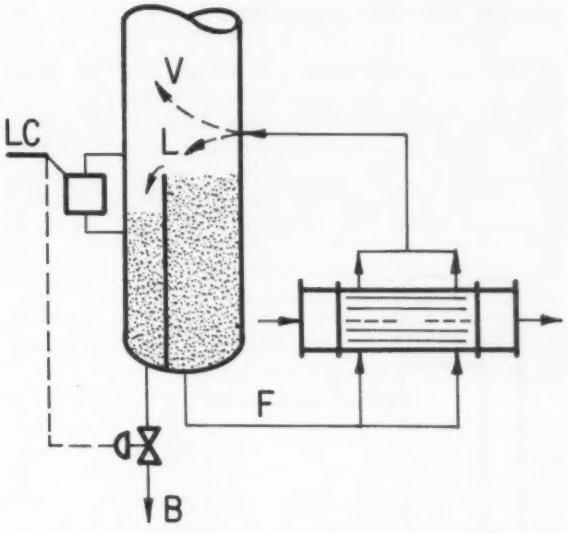

FIGURE 8—Horizontal Thermosiphon Reboiler

ADVANTAGES	DISADVANTAGES
1. Unlimited area	1. High structural costs
2. Can handle fouling heating fluids	2. Large plot area
3. Less rigid hydraulic design	3. Vapor piping complex and costly
4. Can design for high circulation rates	4. Limited to 30% or less vaporization
	5. Process side hard to clean

boiler cost by specifying a fixed tube sheet reboiler.

Thermosiphons should be avoided with viscous fluids, high percent vaporizations, low process flows, and fluctuating feed levels.

Horizontal Thermosiphon Reboilers. For large reboiler area requirements, multiple units of horizontal thermosiphons may be used with common supply and return headers.

Horizontal thermosiphons (Figure 8) boil the process fluid in the shell and are preferable for fouling type heating fluids, but the process fluid is more apt to be susceptible to fouling so that this consideration usually does not favor the horizontal type. Because the process fluid is rarely completely nonfouling, the inexpensive fixed tube sheet construction is seldom used in horizontal thermosiphons.

Since the horizontal thermosiphon is independently supported and since the multiple shell units in a single tower service may not be stacked, foundations and structural mountings are costly and plot area requirements may be quite large.

Vapor piping can become relatively expensive and cumbersome with horizontal thermosiphons. However, since the vapor line may enter the tower well above the top of the reboiler tubes, there is considerably more leeway in liquid level and hydraulic design is more flexible. High recirculation rates may be attained even with complex piping.

In order to thermosiphon well, horizontal thermosiphons are usually furnished with horizontal baffles to force the process fluid to travel back and forth in the shell. Longer units often use a split horizontal baffle with dual process fluid inlets and outlets. Hydraulic and thermal balance prevails between the opposing sides of the shell so that satisfactory thermosiphoning proceeds in such dual baffle units with length to diameter ratios as high as 12 to 1.

Kettle Reboilers are limited to once-through type operations. The gross bottoms is fed from the bottom of the tower and the net bottoms withdrawn from the reboiler.

The most common design of kettle, as shown in Figure 9, uses natural liquid circulation. Net bottoms flow is independently controlled, and the weir in the kettle maintains reboiler tube immersion as well as the level in the bottom of the column.

With kettle reboilers the bottom section of the column is greatly simplified. No baffle, trap-out, collector tray, or level control is required. Tower bottom height is minimized, since liquid holdup and vapor disengagement occur in the kettle. Piping is simplified, although vapor lines are much longer than those of vertical thermosiphons.

Multiple kettle units with common inlet and discharge headers may be used for large installations. With clean heating fluids, inexpensive U-tube bundles are often employed rather than floating heads.

Since the horizontal cross-section of the discharge chamber of a kettle is usually smaller than that of the column, bottoms product surge capacity is inferior to that of most other reboiler systems. The response characteristics of the controller and system holdups are such that column level controls generally produce steadier net bottoms outputs than those of kettles. In cases where the

net bottoms product goes to a storage or surge vessel, unsteady bottoms flow need not be a consideration.

In other reboiler systems, vapor liquid disengagement occurs in the lower part of the column, with the bottom plate or the packing serving to insure efficient separation. In a kettle, disengagement volume must be provided above the tubes. The disengagement requirement together with the liquid discharge chamber requirement, makes the kettle a relatively expensive form of reboiler. To the fabrication cost of the kettle and its internals must be added the additional costs (above vertical thermosiphon costs) of vapor piping and of foundations and supports, particularly when a high tower skirt is needed.

Kettles are essentially vaporizers and are frequently used with high percent vaporization. Since kettles tend to be dirt traps and lack the high liquid velocities characteristics of thermosiphons, it is advisable to limit vaporization to 80 percent unless the process fluid is clean. In this way the 20 percent net bottoms serves as blowdown, although dirt accumulation may not be effectively limited by net bottoms withdrawal in some types of fouling service.

Because of the large holdup in the boiling section, the liquid tends to boil at close to net bottoms temperature and thermal fouling may become excessive. However, it is a relatively simple matter to remove or replace a kettle bundle and clean out the kettle. Because recirulation is avoided, kettle reboilers may be advantageous for thermal fouling of the polymer type.

Kettles are also used without weirs. In this case the level is controlled by a baffle or level control in the column. The bottoms product is then a mixture of net and gross bottoms so that a fraction of a stripping plate is lost. In this system it is important to avoid excessive vapor line pressure drop which will tend to depress the kettle liquid level and uncover the upper tubes.

Kettles are expensive. They should be avoided with highly viscous liquids and in heavy fouling service.

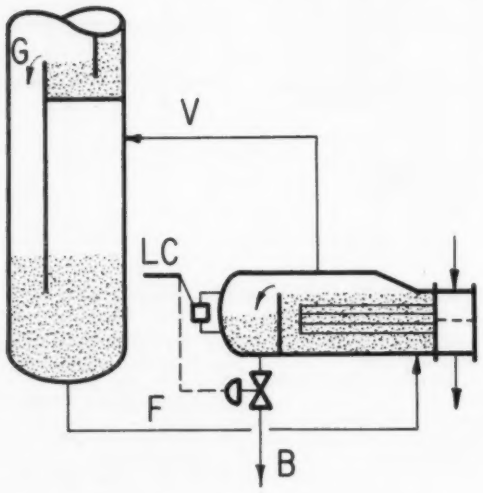

FIGURE 9—Kettle Type Reboiler

ADVANTAGES	DISADVANTAGES
1. Can handle high vaporization (up to 80%)	1. Generally limited to once-through operation
2. Simple bottom column internals	2. Net bottoms surge capacity small
3. Simple piping	3. Expensive exchanger construction
4. Unlimited area	4. High structural costs
5. Cheaper U-tube bundles usable	5. Tend to be dirt traps

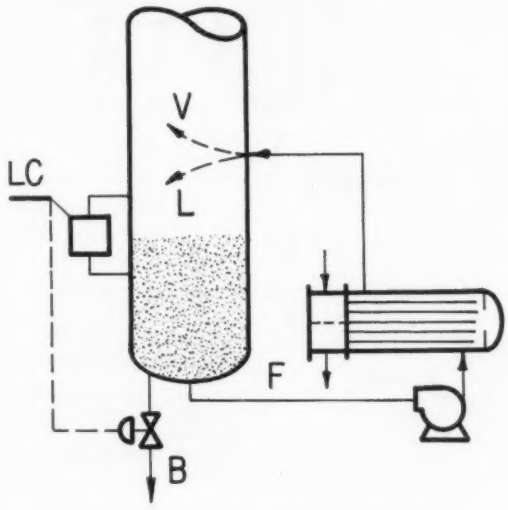

FIGURE 10—Pump Through Reboilers

ADVANTAGES	DISADVANTAGES
1. Mandatory for viscous bottoms	1. High pumping costs
2. Often best for high fouling services	
3. Full control of circulation rate	
4. Operable at very low vaporization rate	
5. Can use standard exchangers	
6. Can use high liquid transfer rates	
7. Can use smaller piping	
8. Often best for small columns and small flows	

Pump-Through Reboilers. Reboiler feed pumps (Figure 10) are mandatory where bottoms are viscous enough to impede natural circulation.

Pumps are highly advantageous in fouling services since the high velocity promotes washing action and thin films. Extremely high circulation rates may be used, so that unbaffled net bottoms feed systems may be employed with litttle temperature rise in the reboiler. In a few such cases it is possible to combine bottom product and reboiler feed pumping.

Pumps permit full control and measurement of reboiler feed circulation, improve liquid transfer rates, and permit the use of conventional standardized exchanger units in reboil service. They are often useful in cases where hydrostatic head is limited.

Pumps are frequently used in small installations in order to effectively utilize an unbaffled column and to control small flows. They are also used in large installations, particularly in multiple kettle units, since natural liquid circulation may not be efficient with complex piping.

Pumps may permit substantial savings through smaller pipe lines (particularly vapor lines) and through more convenient and perhaps lower location of reboilers.

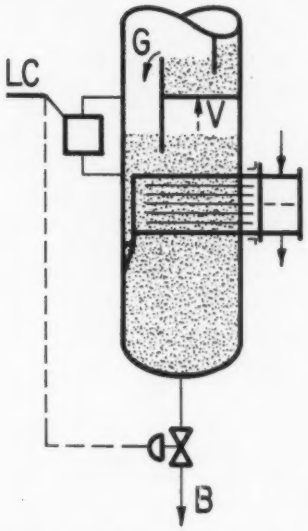

FIGURE 11—Internal Type Reboilers

ADVANTAGES	DISADVANTAGES
1. No shell costs	1. Limited to relatively small duties
2. No process fluid piping	2. Requires large flange and an internal support
3. No baffling in column	3. Short tubes and costly bundle
4. Process fluid leakage minimized	4. Must shut down column to clean. No alternating operation possible

Pump-through systems avoid many of the design problems of thermosiphon hydraulics.

Unfortunately, these many advantages are usually over-balanced by the continuous operating costs, fixed charges, and maintenance requirements of the pump.

Internal Reboilers. In rare cases where reboiler duties are relatively very light, it may be advantageous to employ a bundle in a submerged trap-out in the bottom of the tower as shown in Figure 11.

Shell costs are avoided and all reboiler piping is eliminated. No baffling is required but internal supports and often a large column flange must be provided. The bundle is relatively expensive since it uses many short tubes.

In very small towers, with removable heads, a coil in the bottom section of the tower is sometimes used for reboil heat.

Calculation of Reboiler Feed Systems

In the following calculations it is assumed that vapor and liquid are in equilibrium and that perfect liquid mixing occurs in the lower column compartments.

In each case the reboiler vapor is to be found for a given reboiler duty, net bottoms composition and bottoms pressure. The gross bottoms temperature and composition will also be determined. Determination of the reboil vapor in a net bottoms feed system requires also a knowledge of the percent vaporization. The percent vaporization is required only to determine the feed temperature to a gross bottoms feed reboiler. (Note: By reboil vapor is meant the quantity and composition of the vapor leaving the reboiler. Percent refers to the quantity of reboil vapor as a fraction of the liquid feed to the reboiler and is usually expressed as weight percent.)

Since thermosiphons operate poorly above 30 percent vaporization a maximum design percentage would be 25 percent, while 20 percent is a useful rule-of-thumb design rate. Where it is desired to minimize reboiler feed temperatures in a net bottoms feed system, a percent vaporization as low as 10 percent is often used. High circulation rates and liquid velocities may also be desirable in certain types of fouling services where the deposits are susceptible to removal by a washing action. Since kettles are effective dirt traps, it is customary to design them for a maximum of 80 percent vaporization for typical hydrocarbon fouling services.

A typical preliminary calculation of the reboiler duty might be based on a given net bottoms and net overhead, a known feed enthalpy and a given cooling medium supply temperature. In this particular tower process calculation scheme it is assumed that the reboiler heating fluid is at a sufficiently high temperature and that a total condenser is to be used.

1. Select the net overhead temperature at an economic approach to the cooling medium supply temperature.

2. Determine the condensate receiver pressure by bubble point of the net overhead. (e.g., Find pressure such that $D = \Sigma K_n D_n$ where the K's are taken at assumed pressures and the net overhead temperature.)

3. Determine the top column pressure by adding the anticipated condenser pressure drop to the condensate receiver pressure. Find the bottoms pressure by further adding the anticipated tower pressure drop.

4. Determine the net bottoms temperature by a bubble point of the net bottoms. (e.g., Find temperature such that $B = \Sigma K_n B_n$, where the K's are taken at assumed temperatures and the bottoms pressure.)

5. Determine the temperature of the gross overhead by dew point of the net overhead, since a total condenser is specified. (e.g., Find temperature such that $D = \sum \frac{D_n}{K_n}$, where the K's are taken at assumed temperatures and top column pressure.)

6. Select an economic reflux rate from a (Gilliland) plot of reflux ratio vs theoretical plates, based on minimum reflux (Underwood), and minimum plates (Fenske).

7. Find the condenser duty to cool net overhead and reflux from vapor at top column temperature and pressure to liquid at net overhead temperature.

8. Find the enthalpies of the net overhead, and net bottoms from known quantities, temperatures, and compositions. Feed enthalpy has been given.

9. Find the reboiler duty by an over-all tower heat balance where the reboiler duty plus the feed enthalpy must equal the sum of the net overhead and net bottoms enthalpies plus the condenser duty plus the estimated tower heat loss.

Calculation of Vapor Rate With Net Bottoms Reboiler Feed. Basis: Specified reboiler duty, net bottoms, and bottom pressure and selected vaporization rate.

1. Find net bottoms temperature by bubble point (e.g. such that $B = \Sigma K_n B_n$, where the K's are taken at an as-

sumed temperature and bottoms pressure.) Note that this is also the reboiler feed temperature. This step may have been done as step 4, preceding page.

2. Select a molal fraction vaporization rate $\frac{V}{F}$ (say 0.20) and find the corresponding $\frac{L}{V} = \frac{F}{V} - 1$.

3. Using this L/V, determine reboil vapor temperature and composition by equilibrium flash of net bottoms (e.g., such that $B = \frac{F}{V}\sum \frac{B_n}{\frac{L/V}{K_n} + 1}$, where the K's are taken at an assumed temperature and bottoms pressure. Note that $\frac{F}{BV}\frac{B_n}{\frac{L/V}{K_n} + 1}$ then gives the mol fraction of each component of the reboil vapor.) From this composition the molecular weight of the vapor may be calculated and the weight percent vaporization checked.

4. Determine the reboiler feed and vapor rates by a heat balance on the reboiler, in which the reboiler duty is used to heat F mols of reboiler feed of net bottoms composition from net bottoms temperature to reboiler vapor temperature and to vaporize $V = \frac{V}{F} \times F$ mols of reboil vapor at the reboiler exit temperature. (This can also be done on a weight basis.)

5. Calculate the composition of the gross bottoms as the reboil vapor plus net bottoms.

$$G_n = B_n\left[1 + \frac{F}{B\left(\frac{L/V}{K_n} + 1\right)}\right]$$

6. Calculate the temperature of the gross bottoms by bubble point (e.g., such that $G = \Sigma K_n G_n$, where the K's are taken at assumed temperatures and bottoms pressure). Note that the mol fraction of each component in the vapor leaving the bottom theoretical plate is given by $\frac{K_n G_n}{G}$.

Calculation of Vapor Rate With Gross Bottoms Reboiler Feed. Basis: Specified reboiler duty, net bottoms and bottoms pressure.

1. Bubble point on net bottoms at bottoms pressure gives reboil vapor temperature and composition. (Reboil vapor temperature is also net bottoms temperature.)

2. Assume a gross bottoms temperature and composition (or molecular weight or liquid heat capacity) and estimate the net bottoms duty necessary to heat the net bottoms from gross bottoms to net bottoms temperature. (Gross bottoms temperature is also reboiler feed temperature.)

3. Estimate boil-up duty as reboiler duty less net bottoms duty.

4. Estimate the reboil vapor rate by heat balance using the boil-up duty to produce vapor at reboil vapor temperature from liquid at gross bottoms temperature.

5. Estimate the gross bottoms as the sum of the estimated reboil vapor plus the net bottoms. If the composition or the temperature determined by bubble point on the gross bottoms differs significantly from that assumed, repeat steps 2, 3 and 4.

Calculation of Vapor Rate With Mixed Bottoms Reboiler Feed. Basis: Specified reboiler duty, net bottoms and bottoms pressure.

1-5. Proceed as in steps 1 through 5 of calculation method for gross bottoms reboiler feed, noting that the gross bottoms temperature is not now equal to the reboiler feed temperature.

To calculate reboiler feed temperature, using a selected percentage vaporization:

6. Find quantity of reboiler feed as vapor divided by fraction vaporized and quantity of reboiler exit liquid as feed quantity less reboil vapor.

7. Quantity of reboiler exit liquid recycle is then total reboiler exit liquid less net bottoms.

8. Assume equal specific heats and estimate reboiler feed temperature as weight average temperature of gross bottoms and recycle liquid. If necessary, check this temperature by a heat balance in which the sum of the enthalpies of the gross bottoms and reycle equals that of the reboiler feed.

NOMENCLATURE

- B — Net bottoms—mols per hour
- D — Net overhead—mols per hour
- F — Reboiler feed—mols per hour
- G — Gross bottoms (Bottom plate liquid overflow)—mols per hour
- K — Vapor-liquid equilibrium constant
- L — Liquid leaving reboiler—mols per hour
- V — Vapor from reboiler—mols per hour
- n — Subscript referring to each of the single components in a mixture
- LC — Level Control
- REB — Reboiler

Key Words for Indexing

Bottoms
Computations
Feeds
Internal
Kettle
Pump-Through
Reboilers
Thermosiphon
Vapor Rate

##

About the Author

Jacobs

John K. Jacobs is a chemical engineer with Stone and Webster Engineering Corp., Boston. His duties involve process design for petrochemical plants. Mr. Jacobs holds a B.S. and a M.S. degree in chemical engineering from the Massachusetts Institute of Technology and has had 20 years experience in the process industry alternating research and development with process design and economic studies. Before assuming his present position, he worked with United Engineers in Philadelphia. He is a registered engineer in Pennsylvania.

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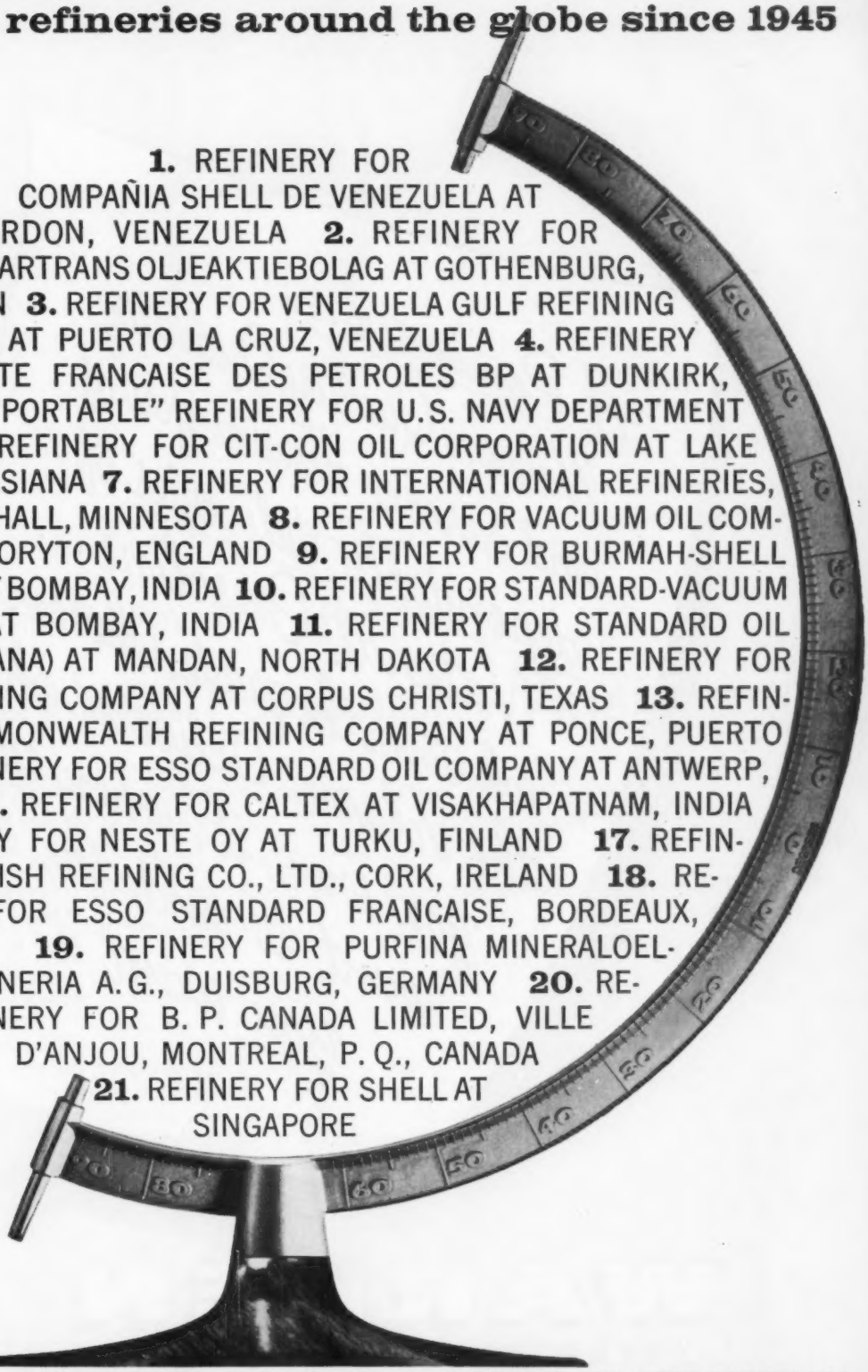

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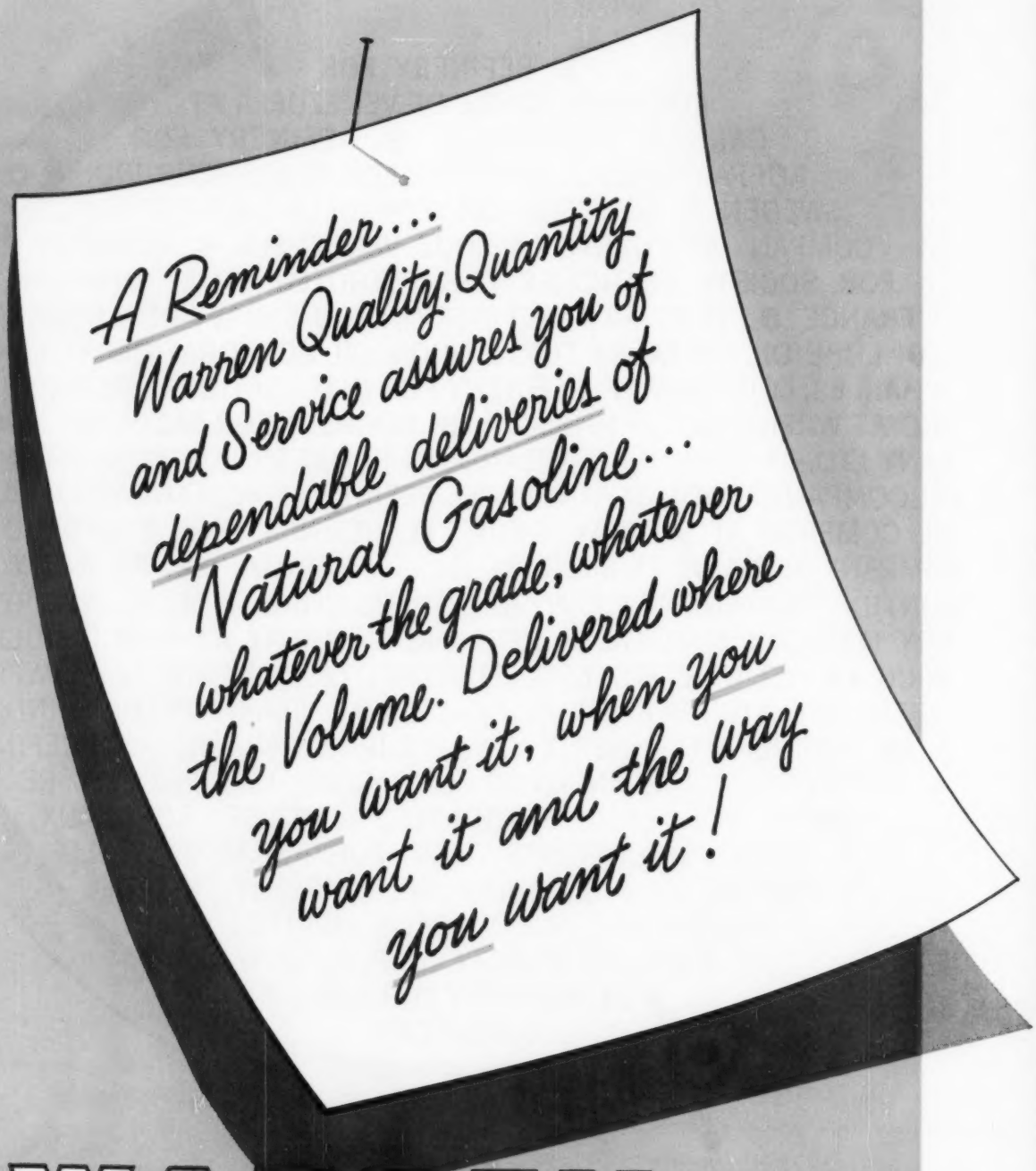

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FIGURE 1—While no living man is a "pure" type, these three faces are examples of (left to right) Round, Muscular and Thin faces. There is good evidence that their behavior differs as fundamentally as their faces.

Judging People by Physique – Part 1

The Body and Personality Analysis

The technique of evaluating people by what we "see" has existed longer than any other, but has been sidestepped as "unscientific." Here, a noted artist delves into a controversial subject on which some segments of science are taking a less negative stand.

Emery Kelen

Some time ago, the personnel director of a large industrial enterprise, to whom I tried to explain the advantages for management in learning the proper way to judge people by physique, told me, "But, Mr. Kelen, your approach would revolutionize our whole concept of industrial relations."

I don't deny it. I am convinced that present-day methods of evaluating the abilities of personnel by diplomas, certificates, discharge papers, questionnaires, report cards, and a snowdrift of paper work, tell an incomplete story.

Personality evaluation must begin with the foundation on which the personality structure stands: *the innate talents and shortcomings laid down in a man's constitution and expressed in the static and dynamic aspects of his body build.*

What do you do when you meet a man. You "give him the once over," observing his hairdo, grooming, haberdashery, and whether he has a square jaw, shifty eyes, sour puss or friendly smile. What you see in that first swift glance is not without importance. Like cats, dogs, and birds in the trees, we have an inbuilt talent for sensing like or unlike, friend or foe. It is an intuition implanted in all of us by Mother Nature, which helps us find our way among our fellow men.

Still, most people feel uncertain about their first impressions, and I don't blame them. The average person doesn't know how to interpret what he sees and hears, or how to evaluate his natural hunches. Unaware of modern scientific research which might come to his rescue, and frightened by such discredited approaches as "physiognomy," and "phrenology," he feels it safer, fairer, more democratic, to suppress his intuitive knowledge.

Yet perhaps I can persuade my reader to reflect: if Providence has bestowed on us such persistent instincts to weigh our fellow men as we see them, and all arguments don't stop us from doing so every day of our lives, maybe there's something in it worthy of a new look!

The basic principles on which I base my theory are so simple that my reader might feel he has always known them. He may realize that if his own observations about people were placed in proper order, he could be aided in judging, if not everything, certainly a lot—just by looking at his fellow man.

By profession, I am a portrait-caricaturist, whose job for forty years has been to look at people. I must have drawn from life some 25,000 portraits of statesmen of all races,

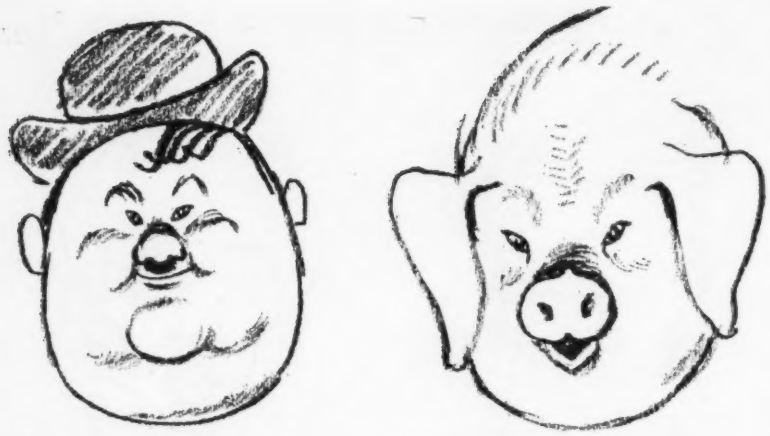

FIGURE 2—The porky look comes from a weak, sunken, narrow, upper jaw. It bestows special shrewdness to the practical, humorous Round-Muscular man.

creeds, and colors. I'd have to be blind, which (as Churchill says) "I ain't," not to notice an intimate connection between the inner man and the outer.

In the late 1920s I made a discovery: that since the turn of the century, outstanding psychologists, psychiatrists, and anthropologists had developed a new science called *constitutional psychology,* with the aim of working out a system for evaluating personality by physique.

It has taken me 30 years and a medical dictionary to understand what the scientists have to say; but along the way I have been able to check my own observations against clinical findings and statistics.

What Can You Judge by Physique? Can you tell by looking at a man whether he beats his wife or his wife beats him? Or whether the bank clerk will run away with the cash, or with the blonde secretary, or both? It would be fun if we could, but we can't, so we won't.

From the outset we must keep in mind exactly what can be judged by physique alone, and what can be judged by other signs.

Man has two different sets of personality traits. The first set are those which are innate, determined by his *constitution*—the living organism of mice and men inherited from a long series of generations in which every little cell has its own memory and personality. How a man or a mouse or a tufted titmouse *looks, behaves,* and *sounds,* is the outward expression of constitution.

The second set of personality traits are those which develop under the pressure of *environment,* that is, upbringing, education, social surroundings—in short, a man's entire life history. These modify, develop, or suppress the original personality traits.

These two sets of personality traits are worked into each other, twisted and rolled into the same dough. In order to keep them apart in our thinking, we shall refer to those personality traits which are part and parcel of the constitution by the elastic term, *temperament.*

Body build and temperament are two aspects of one and the same thing: constitution. They are beans of the same pod. Naturally, one can be judged from the other.

Temperament and Character. When we come to decide exactly what personality traits should be headed by the word, *temperament,* a simple and jolly explanation turns up in a textbook of medical psychology. The term covers, it says, those psychic components of the personality that so frequently and readily respond to alcohol.

Now that peps up our studies. All we have to do is go to the neighborhood bar, and purely in a spirit of scientific research, join the gang. Around us, we see those who after a couple of drinks view life *en rose;* others who cry on our shoulder. Some chatter like red squirrels on a tree, and other old buzzards retire into a corner and scowl. We cannot fail to meet up with the fellow who after three apple jacks can lick any s.o.b. in the house.

After this abbreviated course in practical psychology, the reader will realize that he always knew what temperament was: it is the *deep, inbuilt nature of a man which, as the old Romans used to say, cannot be chased out with a stick, because it returns.*

Temperament decides whether a person is sociable or solitary, aggressive or timid, cheerful or sad, or each in turn. It is a major factor in deciding how men get along with their fellow man. It governs, among other things, the degree of concentration and perseverance, a lively or sluggish mental tempo, a smooth or jerky association of ideas; and whether a man is "observational"—alert to the world around him—or "abstract-minded"—alert to the world inside him.

This is the raw material the parent, the teacher, the pastor, the social worker has to work with in the molding of a child. It is the man your family, your fellow-workers, your foreman and your boss have to cope with *in the long run.* My purpose is to show them how to cope with you from the very beginning!

Look at it this way: the body is a structure—temperament is its function. Structure and function hang together in human beings, not just in cars and cuckoo clocks.

Character is something else. While temperament is inherited, character is a *product* which develops from early childhood by the give and take between inherited dispositions and environment. As time goes by, character gets more deeply ingrained, and becomes man's second nature.

Yet it is easy to grasp the difference between temperament traits and character traits. "Cheerful," "lively," "relaxed," "stiff," "tense," are *temperament* traits. "Faithful," "honest," "decent," are *character* traits, whose development is subject to the individual's education, upbringing, social surroundings, and let's not forget—free will.

While temperament can be safely judged by body build alone, character must be judged on a much broader basis. Concrete observation, not hunches, extend the basis of safe character evaluation.

A Reappraisal. Now that you know something about constitution and temperament, it is time for an agonizing reappraisal of reasoning about the whole matter of judging personality by physique.

A man with a square jaw is not a tough guy because he has a square jaw, but because his constitution hap-

pens to express itself in a square jaw. No doubt, other related features will bear out the evidence of the jaw, such as strong muscles and heavy bones. And such a constitution will include some temperament traits like aggressiveness, courage, love of danger, desire to dominate—all of which add up to a tough guy.

The egghead is not a dreamer because his head is oviform, but because his constitution, which includes such temperament traits as abstract form of thinking, idealism, and devotion to principles, has expressed itself, *along with other outward signs,* in an egg-shaped head.

No square jaw, egg head, or any other isolated feature of the body, taken by itself, can be considered the standard bearer of the personality. *Constitution shows up not in one feature, or two, but in the totality of features, static and dynamic.*

THE INHERITED PERSONALITY

If strolling along the boardwalk at Coney Island on a hot summer day where a million New Yorkers sizzle on the sand, I were to tell my reader that all of these bodies, rare, medium, or well done, could be classified into types, he would perhaps think I had gotten a touch of the sun myself.

Yet he would have to agree with me that on the beach he can count a good number of fatsos, friendly chaps with an acute interest in the picnic basket; musclemen who strut about as if they owned the ocean; and string-beans of the Casper Milquetoast variety covering themselves against the sun in odd garments.

If he notices these types and can tell them apart, he is already on his way to becoming his own, do-it-yourself constitutional psychologist. Because scientists in the United States and Europe who have dug deep into the substrata of the human personality, work with exactly these three types.

By observing them closely, how they behave in insane asylums, clinics, prisons, politics, history, and daily life, psychologists have succeeded in creating a typology, describing these bodies, and the minds that dwell inside them in great detail. This typology can be used as a standard against which to compare and evaluate the entire human stock.

Three Main Types. Every researcher has invented new names for the three types, most of them sounding like ghosts in a Scottish castle rattling their teeth at midnight.

I shall name them in basic English: Round Man, Muscleman, and Thin Man. Here is a thumbnail sketch of each of the types, as I see them, in their theoretically "pure" form.

The **Round Man** resembles a little boy blown up with a bicycle pump. He is made of soft fat, walks on stumpy, knock-kneed legs, and carries a belly made of jelly. His head is globular and flat at the crown, and he has hardly any neck. He stands relaxed, and walks with the floppy grace of a performing elephant.

The Round Man is a joiner type, interested in people, good food, and comfortable living. Like a child he is vain, avid for love, praise, and recognition. He is good natured but moody. He expresses himself easily and does what comes naturally.

The Muscleman is the outdoor type, hard and heavy boned, with big hands and feet. He stands erect and walks on a wide gait like a cowboy. He is a man of action, aggressive, courageous, self-confident. He loves risk, women, booze, gambling. In adverse situations the first thing that enters his mind is to solve it by force. He acts first, thinks after. But whatever he does, he is sure that he is "always right."

The Thin Man is narrow chested, pale and transparent all over. He is loosely put together, as if made of chicken bones. He stands stooped, and walks with the gangling elegance of a skeleton on Halloween night.

He is Caspar Milquetoast in person, mimosa-natured, shy, awkward, sensitive, touchy and fussy. He prefers solitude to the honky-tonk of the market place. He is abstract-minded, systematic, principle-loving, vigilant, and secretive. Before making a decision, he goes into a huddle with a little man inside him.

If everybody were a fatso, a muscleman, or a stringbean, we would all learn the art of personality analysis in kindergarten. But nature has played a trick on us. These types as I have described them in pristine form, are only a theory, a standard for comparison. In the average taxpayer, they are hopelessly intermingled. We see a round head on a lean body, a pinhead on a giant. We meet slender girls walking on piano legs. Shapes get telescoped, welded, molded, and a new array of hybrid noses, jaws, hands, and heads are produced with mongrel postures, voices and temperaments. On any subway we can see almost anything north of the half-man-half-horse line.

The Sheldon Method. This is the jungle where the layman loses the scent. To bring order into it, Dr. Sheldon of Harvard has put forward an ingenious method. He measured and studied many thousands of bodies, estimating in each the degree of participation of the three main types. He found that in the crossing of body types, *temperament followed along,* if not exactly in goosestep, yet in reasonably disciplined order.

Dr. Sheldon's findings are fascinating to me. I consider them very valuable as a basis, a measure, and a guide. Yet it is at this point that I bid good-

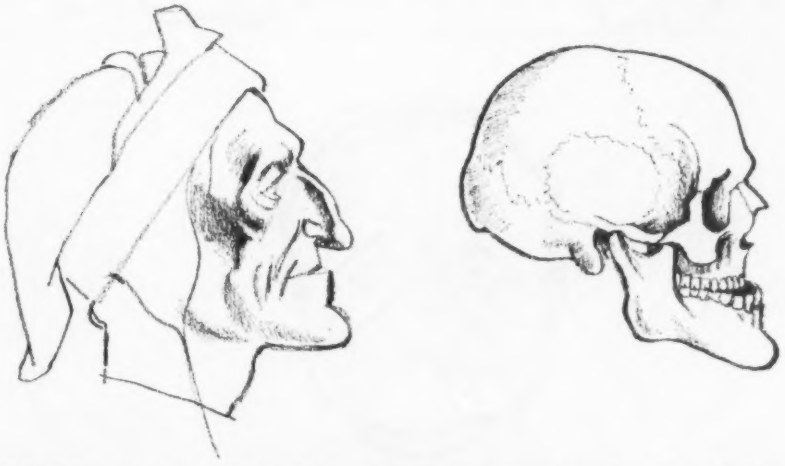

FIGURE 3—Notice the facial skeleton behind the lantern jaw. Here, in the Italian poet Dante, a fragile upper jaw is wedded to a hefty lower jaw. This carries with it a particular type of personality.

bye to my colleagues on the academic bench.

They look mostly at the body. I look above all at the face. While not ignoring by any means the significant information to be gleaned from the terrain south of the necktie, it is in the face that I see most explicitly the greatest variety of welded, molded, and mixed up shapes, exhibited in the smallest possible area.

The face is the visiting card of the personality, as it was inherited, and as it became in the individual's lifetime. Nowhere on the body are such temperament traits as tension, mood, alertness, determination, compassion, so dramatically expressed, and so specified as on the face. In the passing show of facial expression, one sees the speed, smoothness, jerkiness, or lameness of mind-body co-ordination. And it is here that great emotional upheavals, sustained grief or happiness, physical sufferings, and the persistent state of mind write their indelible marks.

Not only the artist, but each and every one of us is better trained to recognize the fine details of a face than of any other part of the body. Our education began in the crib where as babies we searched for eye-contact with the people around us. We swiftly learned the difference between familiar and strange faces. In recent years, since TV swept the land, we have all become much more knowledgeable about faces than we realize.

The face has yet another advantage for our practical, everyday purpose: we want a method of personality evaluation without fuss. The boss, the foreman, the personnel director can't ask his people to take off their shirts. The salesman can't invite his prospects to undress in order to take their xipho-epigastric measurements. We have to judge people by what we see under normal conditions. The first thing we see is the face. As Groucho would say, "It's something you always have with you!"

I don't want to revive the ancient art of physiognomy. My program is an interpretation of the human face in the light of modern constitutional psychology.

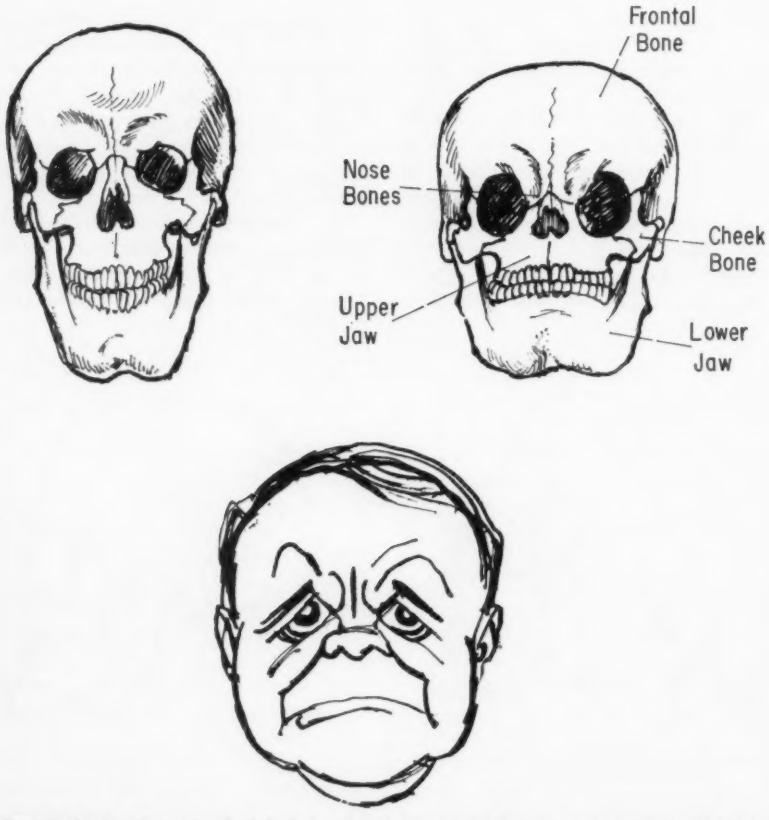

FIGURE 4—Here the facial skeleton of a Bulldog-faced man is compared with a Muscleman. Note how the upper jaw is dwarfed, adding a dash of tension to the already tempestuous Muscular-Round man.

Three Types of Faces. Just as there are three types of bodies, there are three types of faces. In a nutshell, the Round Man's face, known in the vernacular as "pieface" or "moonface" is fleshy and puffy: The nose tip is bulbous, jowls and cheeks are pneumatic, the eyes are big, the lips full. It is but a jumbo-sized baby face.

The Muscleman's face is rugged: jaw and forehead are square, the browridge is like the bumper of a truck, the nose is chunky and equally broad from stem to tip. Under the coarse skin, you can detect tough facial musculature. The teeth are big and strong.

The Thin Man's face is fragile, the nose and chin pointed, the cheeks hollow. Eyes are close set and deep set, and the shape of the face is triangular. Underneath the delicate skin you can see the blue veins, especially on jowls and temples.

Familiar Faces. Each of the three main types of face represent distinct physical and temperamental patterns. When they get crossed, new patterns are formed. Some of them occur so persistently they are familiar to everyone, and we even have names for them in everyday language: bulldog face, horse face, owl face, pig face, monkey face, hatchet face, baby face, lantern jaw, and many more.

I am not playing here Aristotle's old game of comparing men to beasts. I use these terms only because they exist, and you know what I mean by them.

If you have in your organization a man with one of these familiar faces, you can be pretty sure you are dealing with a definite pattern of temperament and behavior. And when you consider that pig face, horse face, owl face, and all the other funny faces I have mentioned can occur in various *degrees,* and can be detected in all sorts of settings, round, muscular, and lean, you will admit that with these familiar faces alone, we can cover a large section of the human race.

In the forest of possibilities, our most reliable guide is the facial skeleton. Each bone or segment of a bone bears the ancestral trademark and contributes its pennyworth to the personality structure.

The character of the face as I see it and as you see it, offers plenty of information about the shape, size, and relative proportions and positions of the bones behind. Such common fea-

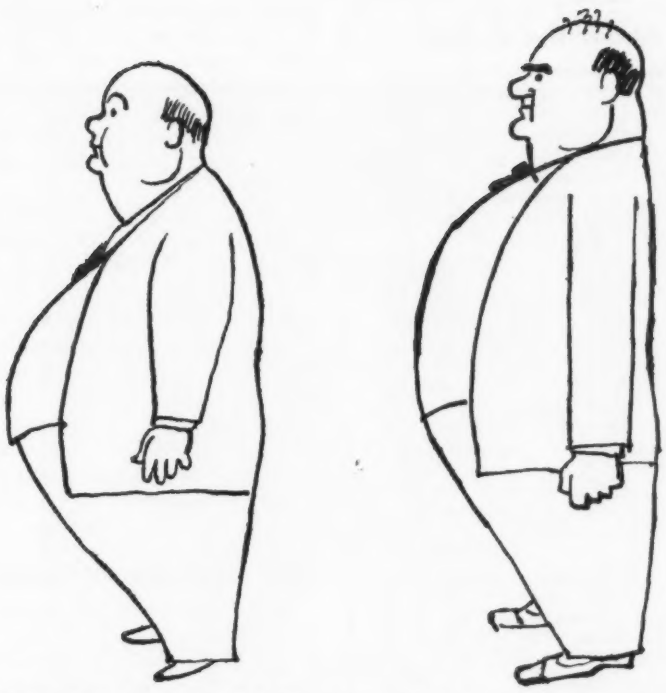

FIGURE 5—This is a typical Soft-Round man and how he looks when muscularity changes him to a human dynamo.

tures as close-set eyes, inward- or outward-slanting eyes, buck teeth, lantern jaw, all have a tale to tell. And what we hear in speech defects such as lisping, or hot-potato speech, reveal anatomical structures of the mouth which have a bearing on personality.

Let's take a longer look at one of the most familiar of features, the *Lantern Jaw*. You have seen it in the faces of Dante, Richard Wagner, Andrew Jackson, and if you peek under the beard of Stonewall Jackson, you'll find another.

The Lantern Jaw is formed by the mesalliance of the sunken and fragile upper jaw of a Thin ancestor, and the relatively hefty and jutting lower jaw of a Muscular ancestor.

The Thin ancestor contributes to the temperament of such a person sensitiveness, abstract mind, inhibition; the husky ancestor bequeaths courage, tenacity of purpose, and assertiveness. Inhibition on the one hand and assertiveness on the other, living side by side in the same individual, will fight a perpetual tug of war.

The above-mentioned men don't look like quadruplets, but with this particular feature in common, we can say with safety that all were tense, touchy, vindictive, courageous, fussy men, full of contradictions. A study of their lives will demonstrate many surprising similarities of behavior where these common characteristics have expressed themselves in similar ways.

The Body Structure. As with faces, type-crossing brings out familiar patterns of physique in the rest of the body, with corresponding distinct patterns of temperament.

One common pattern is formed by a combination of the Round Man and the Muscleman, a type I call the *Human Dynamo*. Potbellied, bullet-headed, strong-backed, with plenty of solid fat, he stands on stumpy legs and dangles flippers instead of arms. Note how frequently this type turns up among politicians and labor leaders on both sides of the Iron Curtain. Good specimens are Khrushchev, Teddy Roosevelt, Michael Quill, Nye Bevan, F. H. LaGuardia. All are men of the same mold. Regardless of differing environment and ideologies, they resemble each other in their swashbuckling, dashing habits, their work-addiction, and "leave-it-to-me" self-confidence; and in their folksy eloquence and showmanship.

You have Human Dynamos in your organization. Note how their special talents and shortcomings resemble those of the people I have mentioned. I have in my attic, many such everyday patterns, all carrying their message.

Disharmony in Body Build. Wherever you see a face, it is usually attached to a body, and usually it matches the body. But not always! Remember Babe Ruth? His bulldog face would normally be seen on a stocky man. His torso was properly barrel-shaped, but he stood on his famous spindle legs. This can only mean that there were great disharmonies in his body build which were reflected in his temperament, making him the great player he was, and the turbulent personality he was.

One must be on the lookout for such disharmonies which are often more instructive than the harmonies.

Other Patterns. Besides those patterns produced by crossings of the three main types, there are other dis-

FIGURE 6—The three basic types of hands are (left to right) Round, Muscular and Thin. It is obvious that these hands can't be expected to be equally efficient at the same job.

tinct patterns which add their pennyworth to the personality.

Femininity appears in men, *masculinity* in women. *Infantilism* can persist in both sexes deep into adult life, and *senility* can set in at an early age.

Body build and motion habits clearly reflect the presence of such patterns, and so does the face. It is useful in all our human relations to recognize them, and to be aware what difference they make to the personality.

Midgets, Giants, and Company. There is an old joke that a normal man is but a giant midget, or else a midget giant. This is more than a mere witticism. Unusual types such as midgets, giants, eunuchoids, and different sorts of idiots are but extreme cases of patterns which turn up in perfectly normal people! It is worth our time to look at the peculiarities of some of these unusual types.

Those little cream-puff midgets who dress up and play Doll's Wedding at the fairgrounds seem to be pocket editions of the typical Round Man: humorous, flexible, good-natured. The bulldog-faced dwarfs who perform in the wrestling arena under such fancy names as "Sky Lolo" or "Big Chief Mighty," with their tremendously strong, almost normal-sized torso and scrubby extremities look like stunted Muscle Men—but they are more agile and more nasty. And those well-proportioned, fragile creatures, dressed as ballerinas in the side-show of Ringling Brothers are miniature Thin Men.

Two varieties of giants fascinate me: one is a giant all over, and sells tin rings to children at the circus; the other is a giant only in parts, with overdimensioned hands, feet, skull, facial skeleton, chest, and shoulders (acromegaly).

Both varieties, though they look intimidating, are sluggish, ponderous, and wobble on their feet. Primo Carnera was a giant all over. In fact, before becoming a heavyweight boxer, he was a professional circus giant. But his poor coordination made him a failure as a professional boxer, and this quality has kept our heavyweight champs from **all** being giants. The Swedish Angel, as well as all the other "Angels" you see falling flat on their backs upon the canvas of the wrestling arena, are cases of acromegaly.

Among diplomats, one quite often runs across a eunuchoid. Their beardless, pasty faces, their rich, soft hair-growth are unmistakable. The feminine sensitivity and sharp wit which is typical of them come in handy in such a slippery profession. American history boasts a star eunuchoid: John Randolph of Roanoke, Jefferson's leader in the House of Representatives. When an opponent remarked on his lack of virility, he scornfully replied: "You pride yourself upon an animal faculty in respect to which the jackass is infinitely your superior!"

The various types of idiots such as pinheads and mongoloids have their particular structure of face and body, as well as distinct behavior patterns.

When signs of such unusual types appear on a normal person, they may be very slight; or they may not necessarily extend all over the body. Dwarfism might be regional, affecting only the legs. Or perhaps only the upper jaw is dwarfed, as in the case of the bulldog-faced man and the bulldog.

In many normal shorties, the participation of one or another pattern of dwarfism is visible. Many comic actors have more than a splash of dwarfism in their makeup. This not only contributes to an unusual appearance, it bestows on them an out-of-the-ordinary personality as well.

You will learn to recognize signs of these unusual types in normal people around you, and to expect peculiarities of temperament to flare up through the normal pattern.

THE ACQUIRED PERSONALITY

If it were possible to raise a man completely cut off from environment, he would still have an expression on his face. This expression would depend on the facial architecture.

On the Round Man's moon face, the inbuilt expression is friendly. On the Muscleman's rugged face, it is serious; and on the delicate face of the Thin Man, the natural expression is vigilant.

Life history modifies the natural expression, and writes its memoirs on the face in indelible ink. Hardship and struggle, or their absence; and how the individual has reacted to outrageous fortune will show up. Age itself will modify the natural expression, the Round Man's cheerful face becoming sad, the Muscleman's serious face hardening, and the Thin Man's vigilant face becoming anxious or simply sour.

And let's not forget that man is not altogether a dummy on the knee of his environment. By his own *act of will* he may change it to a certain degree. Tired of life in New England he may go and live in the Congo. It is up to him whether or not he wishes to educate himself, and to what degree he uses his brain at all.

Whatever life he chooses, as time passes, it leaves marks on the face. That's why Abe Lincoln said, "Over forty, every man is responsible for his face."

Key Words for Indexing
Management Personnel Supervision

Next month, Part II, "A Human Face Can Tell You Plenty."

About the Author

Emery Kelen is a world-famous artist whose portrait-caricatures decorate the walls of the Palais des Nations, the League of Nations Museum in Geneva, and many other government buildings and libraries throughout the world. His limited editions, containing portraits of statesmen of our time are collector's items, and are considered documents of contemporary history. His exhibition in London was opened by the Foreign Minister, Sir John Simon, in the presence of ambassadors accredited to the Court of St. James. In this country, Mr. Kelen's work has appeared in leading newspapers and magazines: *The New York Times, The New York Herald Tribune, Fortune, Esquire, The Christian Science Monitor,* and many others.

For 10 years he was TV producer and director at the United Nations, where his reportage of critical debates—as he saw the drama expressed in human faces—won the highest awards in the country: Emmy, Peabody, Ohio State, and others. He directed the TV coverage of historic speeches before the General Assembly: of President Truman, and President Eisenhower's "Atoms for Peace" speech. His writings on the character of famous statesmen, as he sees it written in their faces, are featured in leading newspapers and magazines in some 20 counties.

Mr. Kelen has drawn, from life, some 25,000 portraits of the famous and infamous of all races, creeds and colors. The observations drawn from this wide experience form the substance of his theories, in which he shows how character is reflected in physique; and that people who look alike, behave alike.

A court's-eye-view of

The Refinery 'Nuisance'

Albert Woodruff Gray

A comparison of recent and old court decisions reveals an "easing up" of the so-called "nuisance" law as it applies to refineries and other processing plants

THE KENTUCKY Court of Appeals recently granted an injunction against construction and operation of a Louisville Refining Co. plant, on the grounds it would be a nuisance. This was another move in decades of legal assaults on the processing industry, usually started by residential-area groups trying to keep industrial development away from homes.

And, of course, there was a time when such litigation may have been justified in many instances. This was the age of open, odorous stacks, flagrant air and water pollution, excessive noise, and other annoyances associated with refining and other manufacturing operations.

However, in recent years the refining and chemical industry has worked hard on advanced, modern equipment and processes to eliminate most of the former nuisances. In this, the industry has been enormously successful. This has resulted in better community and public relations for processing companies. But perhaps best of all is the news that the courts are beginning to acknowledge that the industry has been "cleaned up." The result has been some unprecedented decisions favorable to refining.

A Fresh Approach. A good example of the court's fresh approach to nuisance law as it applies to refining, is a November 1960 decision by the United States Court of Appeals setting aside an injunction granted by a lower court against Commerce Oil Refining Co., Rhode Island. In this decision, the appellate court held that operation of a refinery . . . could not under *normal conditions* be considered a nuisance.

Against Louisville Refining Co. it was charged by property owners in a

nearby residential zone, that . . . units were operated so that the noise was a nuisance which annoyed persons in ordinary life.

In granting this injunction against Louisville Refining, the court said, "A nuisance must be determined by two broad factors, neither independent of the other: (1) reasonableness of the owner's use of its property, and (2) gravity of harm to those seeking relief.

"Both are to be considered in light of . . . the lawful nature and location of the business, manner of operation and importance to the community; the kind, volume, time and duration of the annoyance; the situations of the parties and the character, including applicable zoning, of the locality.

"The extreme limits are . . . reasonable use causing unreasonable damage versus unreasonable or negligent use causing damage more unnecessary than severe."

The American Rule. The court supplemented the above statement with the American Rule—that "The doing of a lawful thing in a careful, prudent manner cannot be a nuisance." To this it added the further comment,

"If industrial plants were located in places suitable to their business, no action for nuisance would lie unless the interference was substantial and unnecessary, or unless the owner was causing more interference than necessary in proper conduct of his business."[1]

Only four months before, the Federal appellate court reviewed the injunction granted on the same grounds against Commerce Oil Refining in Rhode Island. Here, it had been contended that construction of a refinery at Jamestown would be a continuing nuisance to nearby residents.

In granting that injunction the lower court said, "These homes are attractive and well maintained. They afford . . . comfort and enjoyment not found in urban or industrial communities . . . This company now seeks to change the character of the area where these homes are located by building a refinery there."[2]

Commerce Oil's Contention. From that judgment the refining company had appealed—and shortly before this current decision by the Kentucky court the Federal Court of Appeals, in setting aside this injunction against Commerce Oil Refining, said,

"Every person is bound to use his property so as not to injure that of another, or interfere with . . . enjoyment thereof. A business which creates noisome smells, or noxious vapors, or causes disturbing noises or vibrations which injure property or render occupation inconvenient and uncomfortable, is a nuisance. A person whose property is damaged, health injured, or reasonable enjoyment of his estate as a place of residence impaired or destroyed thereby, may . . . recover compensation. And, in such a case a court will restrain . . . by injunction.

"But to secure an injunction against a neighbor's *prospective* use of his property, more must be shown than the mere *possibility* or even *probability* of harm resulting. Unless a proposed use will be a *nuisance in itself* (which is not suggested here, for it is generally held that refineries are not in that catalogue), courts of equity do not readily grant injunctions to restrain anticipatory nuisances."[3]

A Montana Citation. As authority for the statement that "refineries are not in the category of an illegal nuisance," the court referred to a controversy of this kind in a Montana court. Here, an action had been brought against Cut Bank Refining Co. to enjoin erection of a refinery.

The complaint had been made by adjacent property owners that escaping fumes and noxious vapors would settle on these properties with the danger of fire and explosion.

"Refining crude oil," said the Montana court, "is a legitimate business, and such a refinery is not a *nuisance in itself*. However, it may become a nuisance by the *manner* in which it is constructed or operated."

Then of modifications of this rule—permitting issuance of an injunction when the nuisance is not conjecture but real and established, it was added,

"Formerly, equity would not act unless existence of the nuisance had been established in a court. In some late cases, courts have held that equity will not intervene unless nuisance has been found by a jury, or the wrong complained of is a nuisance in itself. But modern practice permits issuance of an injunction without prior action in a court of law.

Liberal View. "Under the modern liberal practice, equity will enjoin construction when the anticipation of danger is *real and substantial* and would be shared by the average person. But the general rule is that in cases of *anticipated* danger equity will not interfere unless its right to do so is absolute.

"In other words, it must be shown that (a) proposed construction or use to be made of the property will be a nuisance in itself, or

(b) that while it may not be a nuisance in itself, a nuisance *must necessarily result* from the contemplated act or thing.

"The injury must be actually threatened, not merely anticipated. It must be *practically certain,* not merely probable. It must further be shown that the threatened injury will be irreparable—uncompensatable by damages (money payment) in an action at law."[4]

Between the legal conduct of refining (with its immunity from interference by neighboring property holders) and operating the kind of business the courts have held subject to injunction-restraint, a line was drawn many years ago by a Kansas court.

A Kansas Case. Situated near a Kansas farm, a refinery discharged oil wastes into a brook flowing across this farm. Damages were awarded the farmer, and the refinery owners appealed.

In its defense the refinery said its business was conducted lawfully and that substances were carried onto the farm land by excessive rainfall for which the refinery could not be responsible. Sustaining this judgment against the refinery, the Kansas court said,

"Whether or not a use in itself lawful is a nuisance depends upon many circumstances—locality and surroundings, the number of people living there, prior use, whether the nuisance is continual or occasional, and extent of injury from the use.

"If the injury is slight, occurring in development of the natural resources of the *land itself* it is not unreasonable. The oil treated at the refinery was obtained *elsewere.* Its operations had no connection with products of the land or development of its natural resources.

"However useful and lawful the business is in itself, the refinery cannot be permitted to cause injury. When the substances came upon the land in excess, the refinery's use of its property became unreasonable and unlawful."

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To this statement the court added a quotation from an English decision. "The person whose corn is eaten by cattle of his neighbor, or whose land is flooded by water from his neighbor's reservoir, or whose home is made unhealthy by vapors from his neighbor's alkali works, is damnified without any fault of his own.

"It seems but just that the neighbor who has brought something on his property which was not naturally there, harmless to others when confined to his own property but which will be mischievous if it gets on his neighbor's, should make good the damage ensuing if he does not confine it to his own property.

"But for his act in bringing it there, no mischief would have accrued. So it seems but just that he should at his peril keep it there so that no mischief may accrue—or answer for the natural and anticipated consequences."[5]

The Old View. This decision adopted, as an authority, the determination of a similar controversy in the late 1800's. That case charted an extreme of the responsibility to which the courts half a century ago held refineries. Oil in this instance had escaped from pipes of the Tide Water Pipe-Line Co., polluting a spring on adjacent property.

From a judgment against it for damages, the pipe line company appealed. In affirming that judgment the Pennsylvania court said,

"If the mere fact that the business is lawful and has been conducted with care would be a defense where a neighbor's land has been injured because of activity carried on there, the result would be that a man might lose his farm. He might have to leave it —without compensation—simply because the business which caused the loss was lawful and careful.

"That is not the law. No man's property can be taken, directly or indirectly, without compensation. Hence, there are many cases where a man is liable in damages although his business is lawful and he has exercised care." Here the court pointed out a distinction recognized even in these earlier decisions.

"In consideration of this class of cases, we must distinguish between natural and necessary development of the *land itself* and injuries resulting from a business not necessary to development of the land or its minerals.

"The owner of land may develop it by digging for . . . minerals. And if, in the progress of this development an adjoining landowner is injured without negligence on his part, an action for such injury cannot be maintained.

"If this were not so, a man might be deprived of using his property. It is not so when the injury is caused by doing business which has no necessary relation to the land itself and is not essential to its development."[6]

The Courts 'Relax.' When 30 years later another similar controversy came before this same Pennsylvania court, an increasing easing of this strict old law became apparent. This court held that business, such as petroleum refining, was a nuisance only insofar as it affected adversely an adjoining land owner.

In Delaware County, Del., a refiner had built gasoline storage tanks, each with a 75,000-gallon capacity. Suit was brought for an injunction against the use of these tanks by adjoining property owners on the ground they were a menace to safety . . . of adjoining lands.

It was held that such circumstances were not grounds for court interference. "An owner has the right, barring malice and negligence," said the court in sustaining dismissal of this action, "to any use of his property unless by its continuous use he prevents his neighbors from enjoying their property to their damage.

"Such use may, under given conditions, be enjoined. Equitable relief must be based on an injurious invasion of a fixed and determined property right. An injury is "something affecting the capacity of the property for ordinary use. Or, it must cause a discomfort in the enjoyment of it that threatens the health or welfare of the occupant with resultant injury to the property.

"As affecting personal discomfort solely, relief depends largely on circumstances of the nuisance and its location. In this age, persons living in a community must subject their personal comfort to commercial necessities."

Logical Conclusion. In this decision the court's conclusion was like that in Montana's Cut Bank Refining case —that is

(a) the proposed construction or use must be a nuisance *in itself*, or

(b) while it may not be a nuisance in itself, a nuisance must result from the contemplated act or thing."[7]

About the Author

Gray

Albert Woodruff Gray has spent 20 years in the independent practice of law, and four years as legal advisor for Young & Rubicam Advertising Agency, New York. Holder of a B.A. degree from Yale College and LL.B. degree from New York Law School, he also spent four years as an editorial writer for Prentice-Hall Publishers, New York. He has published two books on legal subjects, and his articles have appeared in a number of magazines.

With the decision by the Kentucky court a quater of a century later, relaxation of old nuisance law becomes even greater. Near Pikeville, Ky., the owner of a well sued for damages for pollution of his water through drilling of a gas well on adjoining land.

"Present American law departs from the English common law," said the Kentucky court in this recent decision. "It exonerates the owner from legal liability if there was a 'reasonable use' of his property."

"In this state," continued that court, "in accordance with modern trends, even in England, we have rejected the *severe* nuisance doctrine. We must not make one, in the use of his property, practically an insurer against injury to his neighbor's property. The 'American Rule' is that in the absence of negligence there is no liability if there was a legitimate and reasonable use. The doing of a lawful thing in a careful and prudent manner cannot be a nuisance.[8]

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Key Words for Indexing
Laws, Management, Personnel, Supervision

New Books...

As selected by the editors of HYDROCARBON PROCESSING & PETROLEUM REFINER

ASTM Standards

1960 Supplement to ASTM Standards, Including Tentatives, "Part 7—Petroleum Products, Lubricants, Tank Measurement, Engine Tests." American Society for Testing Materials, 1916 Race St., Philadelphia 3, Pa., 320 pages, $4.

Metals Handbook

Metals Handbook: *Properties and Selection of Metals,* Eighth Edition, American Society for Metals, Metals Park, Novelty, Ohio, 1,300 pages, $30.

Several sections include actual operating data obtained in refineries and chemical plants.

Compression Machinery

Scheel, Lyman F., *Gas and Air Compression Machinery,* McGraw-Hill Book Co., Inc. For sale by Gulf Publishing Co., P. O. Box 2608, Houston 1, Texas, 338 pages, $12.

Petroleum Chemicals

Steiner, H., editor, *Introduction to Petroleum Chemicals,* Pergamon Press, Inc., 122 East 55th St., New York 22, N. Y., 200 pages, $8.

ASA Revised Standards

American Standard Method of Test for Knock Characteristics of Motor Fuels Below 100 Octane Number by the Research Method, (ASTM D 908-60) Z11.69-1960; American Standard Method of Test for Knock Characteristics of Motor Fuels Below 100 Octane Number by the Motor Method, (ASTM D 357-60) Z11.37-1960, 30 cents each; *American Standard Maximal Acceptable Concentration of Benzene (for safety), Z37.4-1960; American Standard Maximal Acceptable Concentration of Xylene (for safety), Z37.10-1960; American Standard Maximal Acceptable Concentration of Toluene (for safety), Z37.12-1960,* $1 each, American Standards Association, Department PR 220, 10 East 40th St., New York 16, N. Y.

Boilers

Shields, Carl D., Boilers: Types, Characteristics and Functions, F. W. Dodge Corp. For sale by Gulf Publishing Co., P. O. Box 2608, Houston 1, Texas, 559 pages, $15.

Compressed Air and Gas

Compressed Air and Gas Handbook, Third Edition, Compressed Air and Gas Institute, 122 East 42nd St., New York 17, N.Y., 592 pages, $8.

References range from large-capacity reciprocating or centrifugal compressors to small pneumatic tools.

Organoaluminum

Organoaluminum Compounds, Science Information Association, P. O. Box 2284, Houston 1, Texas, 40 pages, $7.25.

Jet Fuel Analyzer

Czuha, M., Jr.; Gardner, K. W., *An Analyzer for Moisture and Solids in Jet Fuels,* Order PB 171 303, Office of Technical Services, U.S. Department of Commerce, Washington 25, D. C., 27 pages, $1.

Chemical Personnel

Kern, Kenneth R., editor, *Corporate Diagrams and Administrative Personnel of the Chemical Industry,* Chemical Economic Services, Princeton, N. J., 95 pages, $20.

Uses of Multifuels

Uses of Multifuels in Automobile Engines, Office of Technical Services, Business and Defense Services Administration, U.S. Department of Commerce, Washington 25, D. C., 25 pages, 75 cents.

Group Dynamics

Blake, R. R.; Mouton, J. S., *Group Dynamics—Key to Decision Making,* Gulf Publishing Co., P. O. Box 2608, Houston 1, Texas, 120 pages, $3.50.

A popular HYDROCARBON PROCESSING & PETROLEUM REFINER management series in book form.

Safe Handling: Light Ends

Safe Handling of Light Ends, American Oil Co., Supervisor of Safety, Whiting refinery, Whiting, Ind., 89 pages, 50 cents.

For non-technical and technical alike.

Fluid Mechanics

Vennard, John K., *Elementary Fluid Mechanics,* Fourth Edition, John Wiley & Sons, Inc. For sale by Gulf Publishing Co., P. O. Box 2608, Houston 1, Texas, 570 pages, $7.95.

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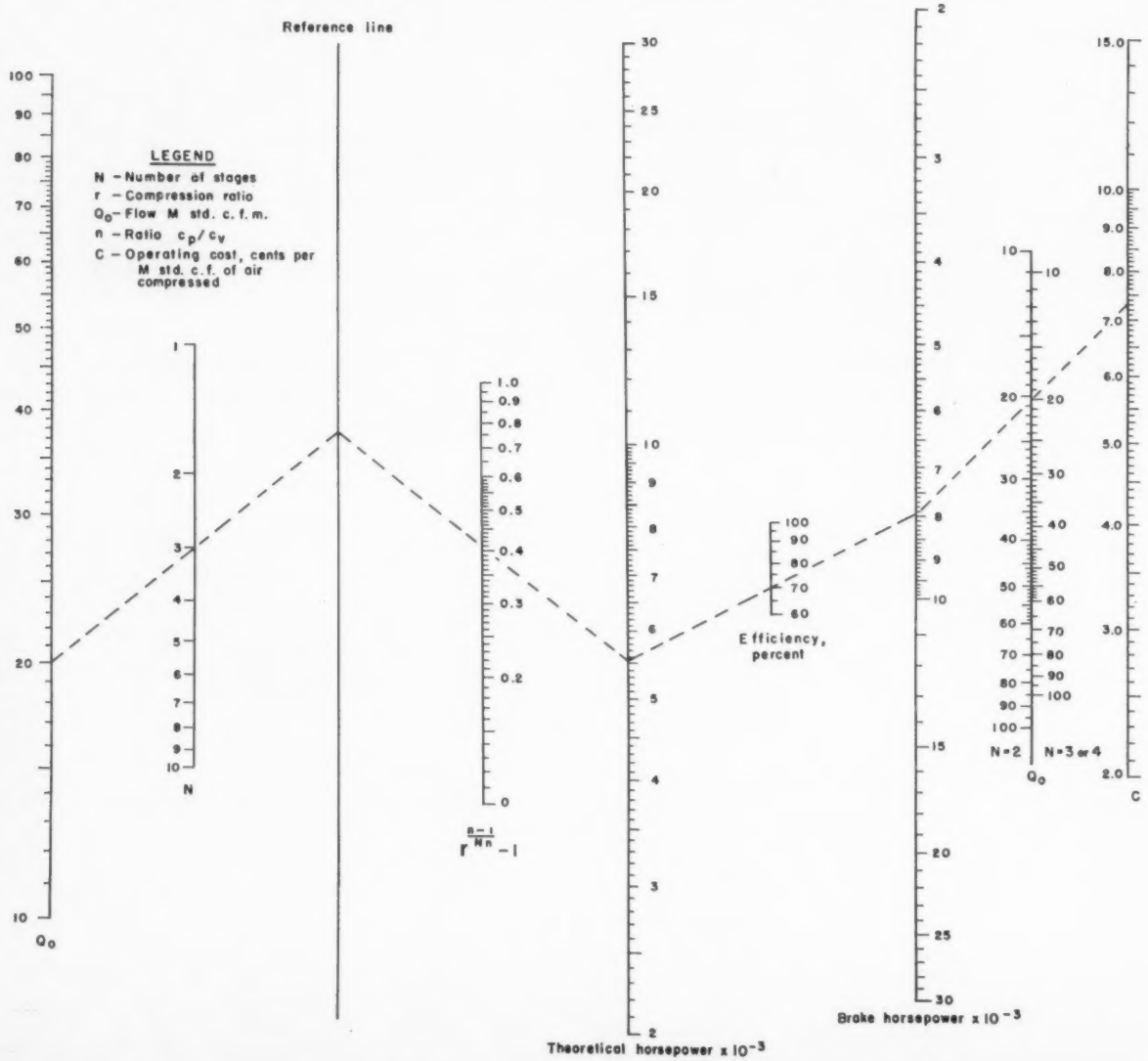
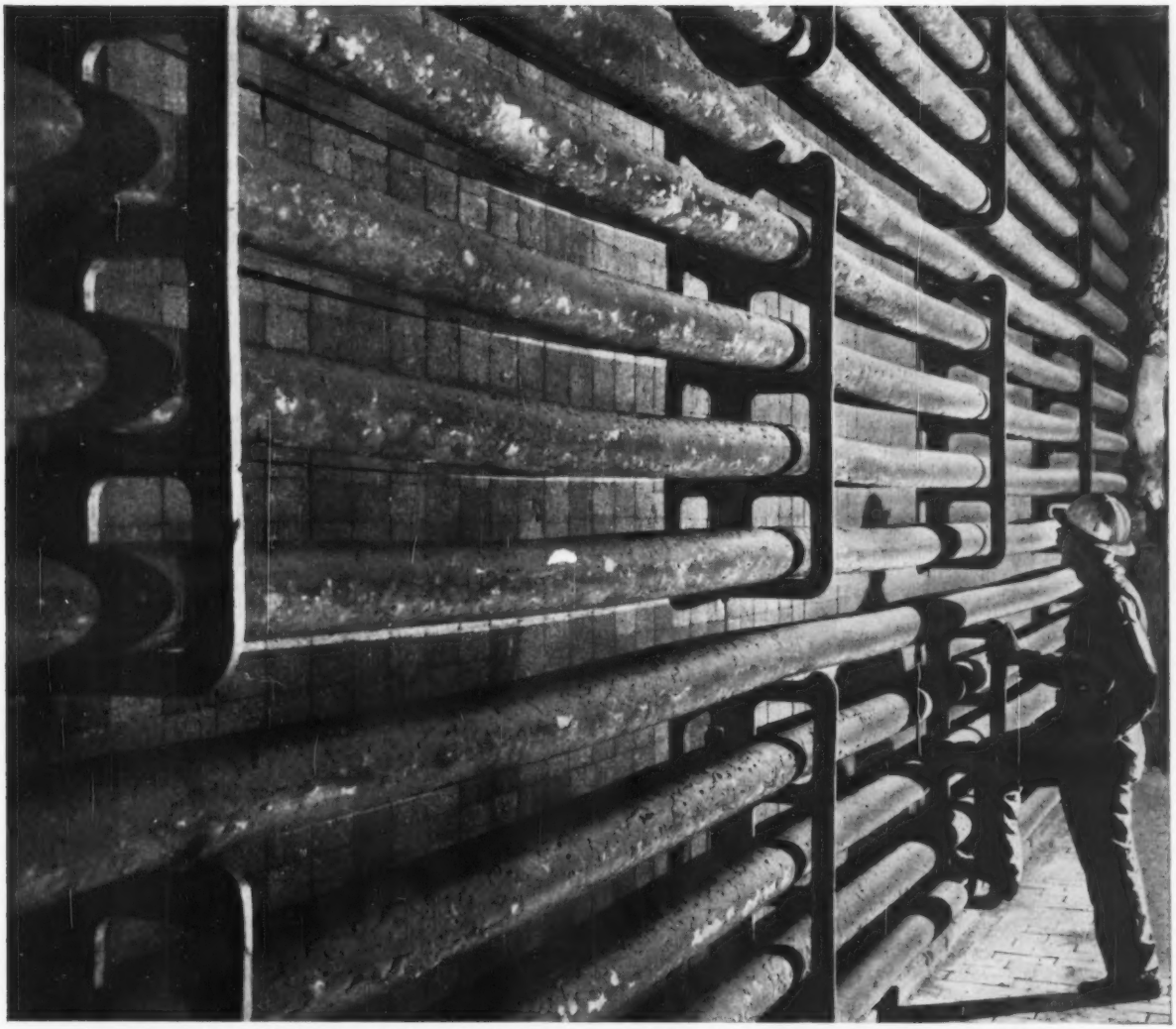
A previous study[1] presented the horsepower requirements and operating costs for centrifugal compressors handling 20,000 to 60,000 standard cfm of air when the discharge pressure varies from 50 to 120 psig. Suction conditions were assumed to be 14.7 psig and 68°F (ASME code). Product air discharge temperature was established as 100°F.

This study covers the flow range from 10,000 to 100,000 standard cfm and the discharge pressure from 50 to 2,000 psig with all other conditions remaining the same.

Theoretical horsepower require-

Figure 1—Horsepower requirements and operating costs for centrifugal air compressors.





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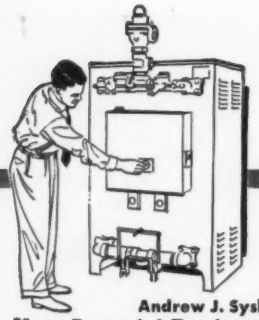

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Table 1—Relationship of power costs to total operating cost

Flow Rate, Std. cfm	10,000		20,000		40,000		60,000		80,000		100,000	
Discharge Pressure, psig	OC[1]	PP[2]	OC[1]	PP[2]	OC[1]	PP[2]	OC[1]	PP[2]	OC[1]	PP[2]	OC[1]	PP[2]
50.....	4.3	47.4	3.4	60.1	2.8	69.4	2.6	73.7	2.4	75.9	2.3	77.4
100.....	5.4	54.2	4.5	65.6	3.9	73.4	3.6	76.9	3.4	78.6	3.3	79.8
500.....	8.2	63.1	7.3	71.5	6.5	77.2	6.2	79.6	5.9	81.1	5.7	82.0
1,000.....	9.9	66.3	8.9	73.8	8.1	78.5	7.7	81.0	7.3	82.3	7.1	82.9
2,000.....	11.4	68.8	10.3	75.9	9.5	80.3	9.0	82.2	8.6	83.5	8.4	84.0

[1] Total operating cost before profit on investment and provisions for Federal income tax with power at $0.01 per kwh, cents per 1,000 cu. ft. [2] Total power cost as a percentage of operating cost.

ments were calculated using the equation[2]:

$$\text{Theor. hp} = 0.08584 \frac{Nn}{n-1} Q_s T_s \left(r^{\frac{n-1}{Nn}} - 1 \right)$$

where:

n = ratio of specific heats,
Q_s = flow rate, million std. cfd,
T_s = suction temperature, absolute, °F,
r = ratio of absolut discharge pressure to absolute suction pressure,
N = number of compression stages.

The calculated results were used in developing the nomograph shown in Figure 1.

To illustrate its use, the nomograph includes, as an example, the determination of the theoretical and brake horsepower and the operating cost of an installation to compress 20,000 standard cfm of air from atmospheric pressure to 500 psig using three-stage compression with an overall efficiency of 70 percent. From the nomograph the horsepower requirements and operating cost are 5,540 theoretical horsepower, 8,020 brake horsepower, and 7.3 cents per 1,000 standard cubic feet of air compressed.

In order to keep the compression ratio per stage below four, the allowable limit for centrifugal compressors,[3] two, three, and four-stage units are used as required. Although single-stage compressors were not considered in the cost analysis, the nomograph includes provisions for determining horsepower requirements for single-stage units.

To establish the actual horsepower requirements, an efficiency factor must be taken into consideration. For centrifugal compressors in the range of this study, this factor will vary from 68 to 78 percent.

Operating costs as determined for this study, and included in the nomograph, are based on the assumption that electrical motor-driven centrifugal compressors would be used. Other drives such as gas engine and steam turbine can be used; reciprocating compressors are available for the service. However, many of the factors that govern the final choice for a particular installation are outside the realm of this study.

The operating costs include power at $0.01 per kwh, cooling water at $0.015 per 1,000 gallons, labor at $2.50 per hour, and payroll overhead at 18.5 percent of payroll. Indirect costs include: engineering, accounting, laboratory, and other items, which cannot be charged directly to the operation of the installation. These are charged as 50 percent of labor, maintenance, and supplies. Property taxes and insurance are taken as 2 percent of investment. Depreciation is assumed as 5 percent per annum. An operating factor of 90 percent is assumed in the calculations.

The major cost element in operating compressors is power. Its effect on operating costs as applied to the present study is illustrated in Table 1. The table lists typical operating costs (before profit and taxes) for air compressor installations when unit power cost is $0.01 per kwh. By applying the following formula, the information in the table can be used to find operating costs with other unit power costs:

$$OC_2 = OC_1 - \left(1 - \frac{PC_2}{PC_1}\right) (OC_1 \times PP)$$

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where:

OC_2 = operating cost at new unit power cost level, cents per 1,000 cu. ft.,

OC_1 = operating cost with unit power cost at $0.01 per kwh,

PC_2 = new unit power cost, cents per kwh,

PC_1 = unit power cost at $0.01 per kwh,

PP = total power cost as a percentage of operating cost.

For example, a compressor producing 20,000 cfm of air at 50 psig will produce this air at a cost of 3.4 cents per 1,000 cubic feet when the unit power cost is $0.01 per kwh. The cost, if power were available at $0.005 per kwh would be equal to

$$OC_2 = 3.4 - \left(1 - \frac{0.5}{1}\right)(3.4 \times .601) =$$

2.4 cents.

As mentioned previously, compressor efficiency will range from 68 to 78 percent. In addition to unit size, other factors such as number of stages, interstage cooling, and degree of cooling enter into the final efficiency rating of the installation. In the development of Table 1 an arbitrary choice was made as follows: 68 percent for the 10,000 cfm unit, 70 percent for 20,000 cfm, 72 percent for 40,000 cfm, 74 percent for 60,000 cfm, 76 percent for 80,000 cfm, and 78 percent for 100,000 cfm.

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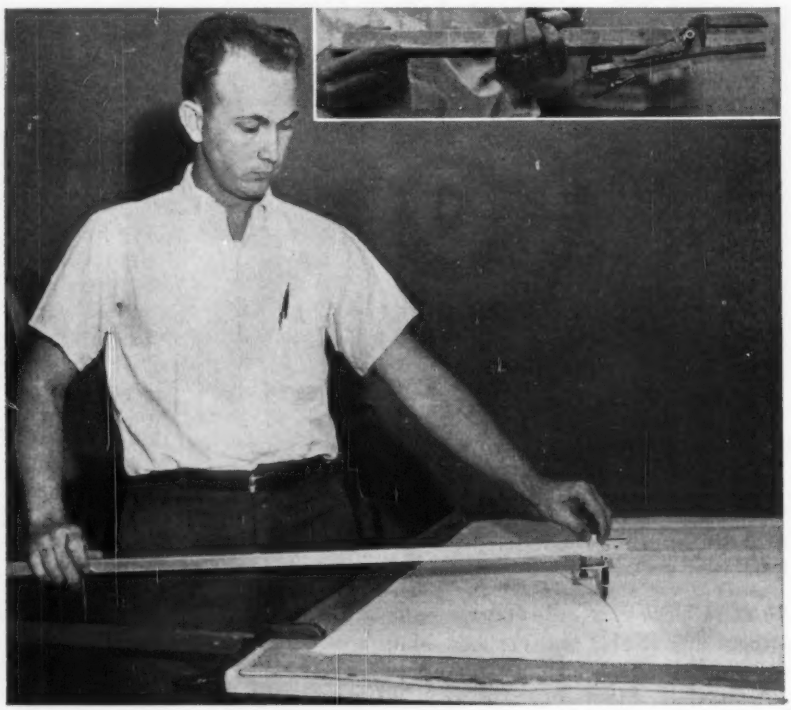
[1] Katell, Sidney, and McGee, J. P., An Economic Study of Air Compression Costs: Cost Eng., Vol. 2, No. 1, January 1957, pp. 5-9.

[2] Beckman, Philip E., Gas Compression: Chapter in Gas Engineers' Handbook, McGraw-Hill Book Co., Inc., New York and London, 1934, 1st ed., pp. 760-772.

[3] Des Jardiens, Paul R., Handling Compressible Fluids in Chemical Processing: Chem. Eng., Vol. 63, No. 6, June 1956, p. 179.



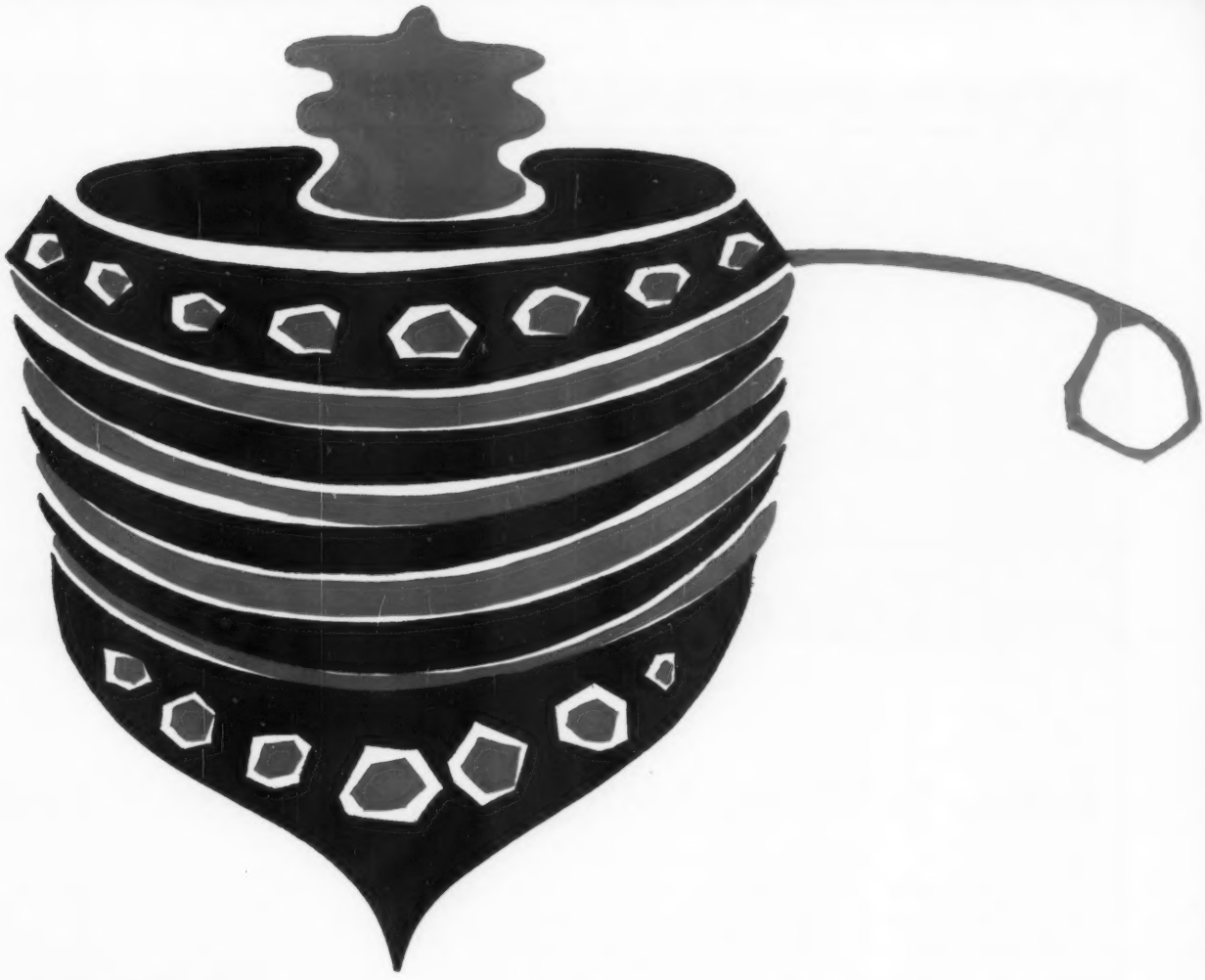
Author demonstrates use of extension clamp.

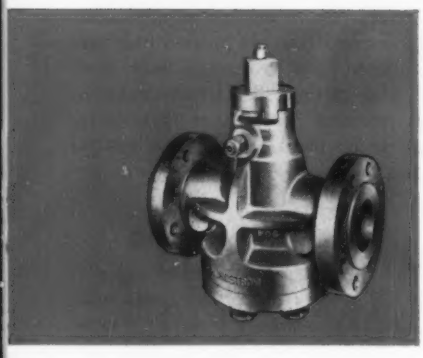
Extend Drawing Board for Large Circle Radii

This handy beam-compass, table extension clamp can be used on drafting tables for drawing circles whose radii are beyond the limits of the table.

It is made from light gage sheet metal with a hardwood insert. Note the clamping device on one end that is hinged for screw clamping to the table edge.

Idea submitted by Royce Baker, Fritz W. Glitsch & Sons, Inc., Dallas.





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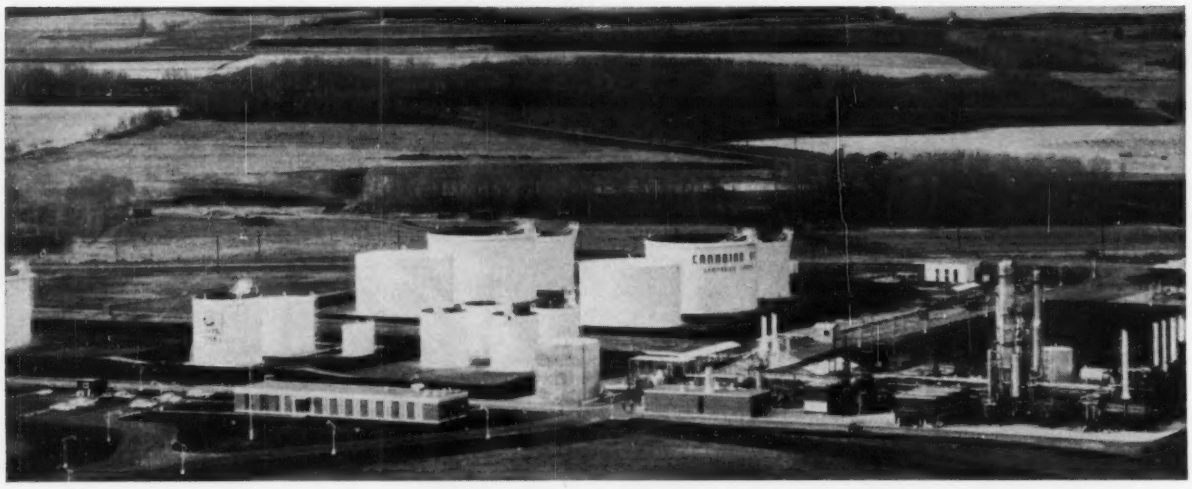
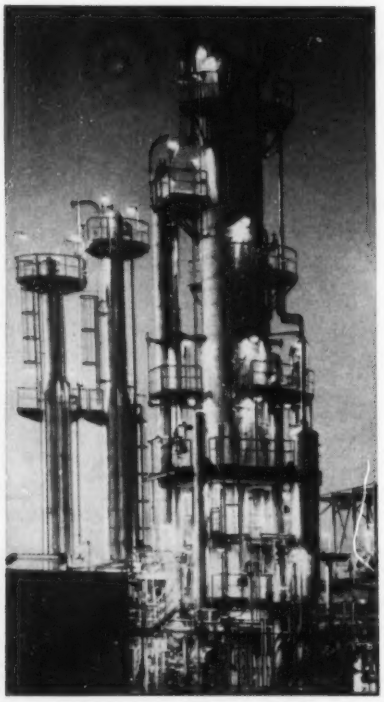


Canadian Oil refinery is picturesque in Alberta terrain.

Alberta Plant Using Condensate Feed

Natural gas condensate is the main feedstock instead of crude oil at a new 5,000-bpd refinery in Alberta.



Plant's feed fractionator.

The plant is so designed that crude can be used as a supplementary feed, however. This condensate eliminates the complications and expense needed to get high yields from crude oil.

Condensate has a high gasoline yield, about 80 percent, with 19 percent distillate fuel oil, and is relatively easy to separate and process into highgrade products.

Located between Bowden and Innisfail, the plant cost $4 million. It will produce 30 million gallons per year of gasoline and about 8 million gallons of diesel and heating fuel.

Condensate most suited to the refinery is produced at the Home Oil gas processing plant near Carstairs, 30 miles south of the Canadian Oil plant.

One of the first condensate refineries in Canada, the plant was designed by Canadian Oil's Engineering Department and Canadian Bechtel, Ltd., which also handled engineering and construction. The facility is believed to be the first in Canada to use air cooling for all processes.

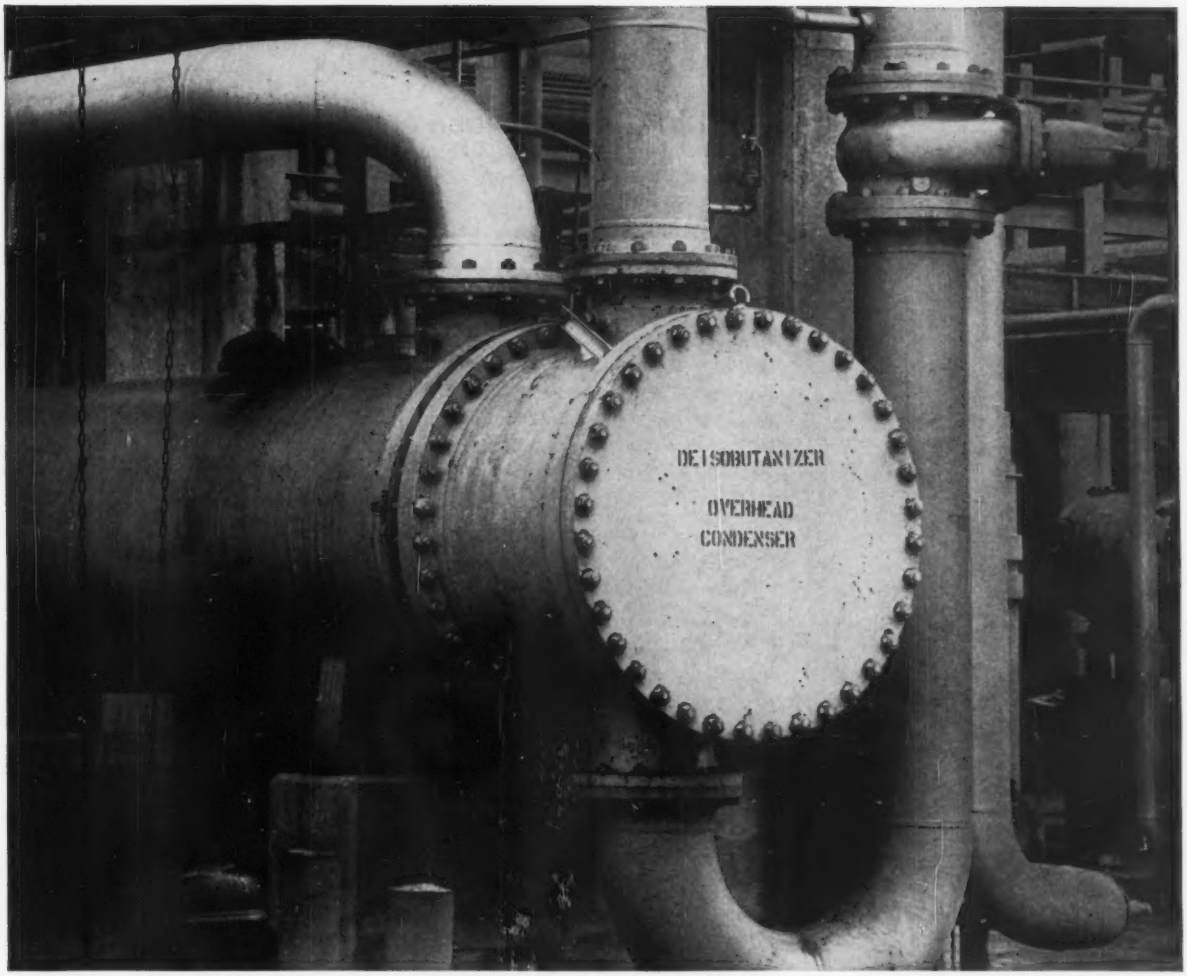
Four Main Processes

Although the refinery has many revolutionary features, its four main processes (feed fractionating, Merox treating, Unifining and Platforming) have been selected for efficiency and ease of maintenance. A new standard of integration is used to arrange the processes on the natural process flow. This formed a single process unit and eliminated much intermediate storage and piping. Electronic automation enables the entire processing cycle to be controlled from a central panel.

In-line Blending

The refinery's in-line blending system has a seperate control room with a panel continuously showing precise flow-rates and proportions. The proportions of the various components, such as inhibitors, dyes, tetraethyl lead and special total gasoline ingredients, can be changed remotely and automatically from the control panel.

Sensing and indicating instruments in the blending system are electronic and the metering equipment is controlled and operated pneumatically from the blending control room. Blending can be carried out at a rate of 360 gallons per minute.



While the DIB overhead condenser continued operating, heavy deposits were cleaned out in just thirty minutes, tripling condenser throughput.

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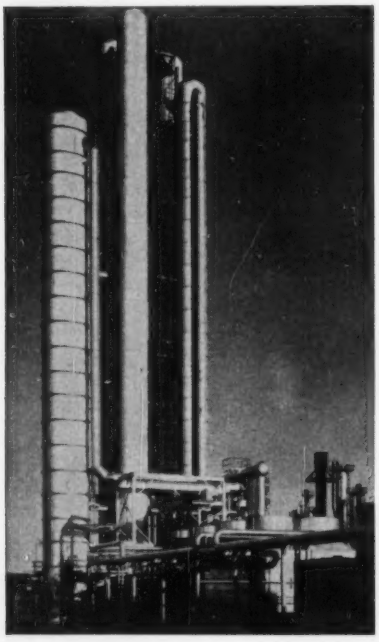
Building . . .

Cosden Completes Styrene Expansion at Big Spring

Two new units which triple Cosden Petroleum Corp.'s styrene capacity



are now on stream at Big Spring, Texas.

The new styrene facilities, adjacent to the original unit, are designed to increase Cosden's capacity from 20 million to more than 60 million pounds annually. The additional ethylbenzene required for the styrene unit is furnished by an Alkar unit, UOP's process for ethylbenzene manufacture through catalytic alkylation of benzene with ethylene.

The design, engineering and construction of the entire project, which includes additional facilities for styrene monomer production, was handled by Badger Manufacturing Co.

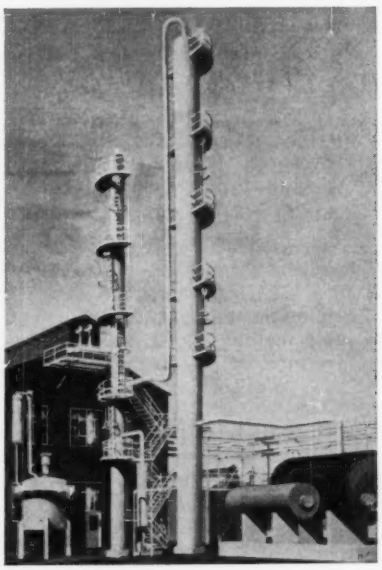
Tenneco Chemical Co. has awarded contracts for a 100-million-pound-per-year acetylene plant and off-site facilities at its petrochemical complex on the Houston Ship Channel. The M. W. Kellogg Co. will build the facility. Work on the off-site facilities will be done by Bechtel Corp. Oxygen supply for the plant will come from Hydrocarbon Research, Inc., which will construct a plant on the Tenneco property. Construction contracts on four additional units of the complex, one of which will produce approximately 200 million pounds per year of vinyl chloride monomer, will be awarded later.

Standard Oil Co. of California plans to spend, out of a $400-million budget, $50 million in chemical projects this year. Last year the company made $156 million from chemicals sales.

The Ohio Oil Co. is expanding the crude capacity of its Robinson, Ill., refinery to 55,000 bpd. The expansion includes revamping a crude distillation unit and expanding fluid cat cracking facilities. The gas-oil charge to the FCC unit will be increased to 24,000 bpd from 20,000 bpd.

Gulf Oil Co. expects to have new benzene-cumene facilities in operation by early next year at its Philadelphia refinery. The cumene unit, according to Gulf Oil, is one of the world's largest.

American Oil Co. will construct a 70,000-bpd crude oil distillation unit at its Sugar Creek, Mo., refinery. Completion is scheduled by July 1, 1962. The unit will replace four existing crude distillation units, three of which are from 30 to 47 years old. Products include: gas, gasoline components, fuel oils, jet fuel, asphalt base stocks, and a gas-oil for cat cracking.



Pitt-Consol Chemical Co. is completing construction of a new plant on its Newark, N. J., site to produce alkylated phenolic and mercaptan derivatives. Completion and full operation of the facility is expected this month.

Standard Oil Co. of California and Humble Oil & Refining Co. have awarded a contract to Black, Sivalls and Bryson, Inc., for the construction of a gasoline recovery plant at Gaviota, Calif. Completion is expected by mid-October. The new facility will handle 30 MMcfd of natural gas, three times the capacity of present equipment.

Shell Oil Co. plans to construct a plant near Yscloskey, La., to recover hydrocarbon liquids from natural gas. Other owners of the project are: The California Co., Cities Service Production Co., Humble Oil & Refining Co., Continental Oil Co., The Atlantic Refining Co., and Tidewater Oil Co. The plant will be on a 30-acre site about 30 miles southeast of New Orleans. It has been designed to process up to 650 MMcfd of gas. It will extract about 10,000 bpd of hydrocarbon liquids. Completion is set for May 1962.

Stauffer Chemical Co. and U.S. Smelting Co. will build a plant in Utah to make coke from coal by a new process. It will be located at Midvale, 10 miles south of Salt Lake City. Completion is set for late 1961.

Union Carbide Chemicals Co., Division of Union Carbide Corp., has awarded a contract to Badger Manufacturing Co. for the process design, engineering and procurement for a 50-million-pound-per-year fluid-bed phthalic anhydride unit. The unit, to be constructed at Institute, W. Va., is expected to be completed in late 1962.

Morton Chemical Co., a subsidiary of Morton Salt Co., will build an anhydride hydrogen chloride plant at Geismar, La. The plant will devote its entire output to Borden Chemical Co. and U.S. Rubber Co.'s Monochem, Inc., under long-term contracts.

Republic Natural Gas Co. will build a refrigeration plant in Texas County, Oklahoma, to extract natural gasoline and heavier hydrocarbons. Construction will begin sometime late this summer.

Standard Oil Co. of California "will likely" build a refinery on the Gulf Coast to supply the products needs of Standard Oil Co. of Kentucky upon Standard-Kentucky's supply contract expiration with Humble Oil & Refining Co. Such a refinery is mentioned in the consent decree

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Building . . .

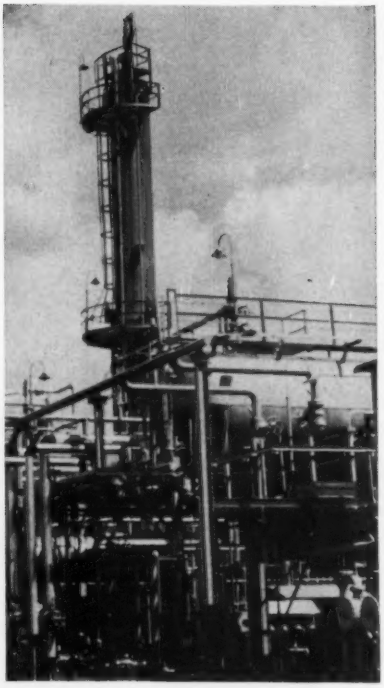
in the U.S. Justice Department's case against Standard-Kentucky and Jersey Standard.

American Oil Co. is building a crude oil distillation unit at its Casper, Wyo., refinery to process 37,000 bpd. Completion date is September 1 this year. The unit will fractionate crude oil into intermediate streams to be processed into gasoline, distillates, lube oils, wax and asphalts.

Shell Chemical Co. has begun manufacturing polystyrene at its Wallingford, Conn., plant. Initial annual capacity is 40 million pounds.

Phillips Has Butamer Unit On Stream at Borger Plant

Phillips Petroleum Co. is producing about 4,500 bpd of isobutane with a UOP Butamer unit on stream at the Borger, Texas, refinery. Process design of the unit was by Universal Oil Products Co. Mechanical design and construction was by Phillips. Isobutane from the unit is used in producing alkylate. The process uses a high-activity catalyst developed by UOP to permit operations at the low temperatures especially desirable for butane isomerization.



UOP Butamer unit.

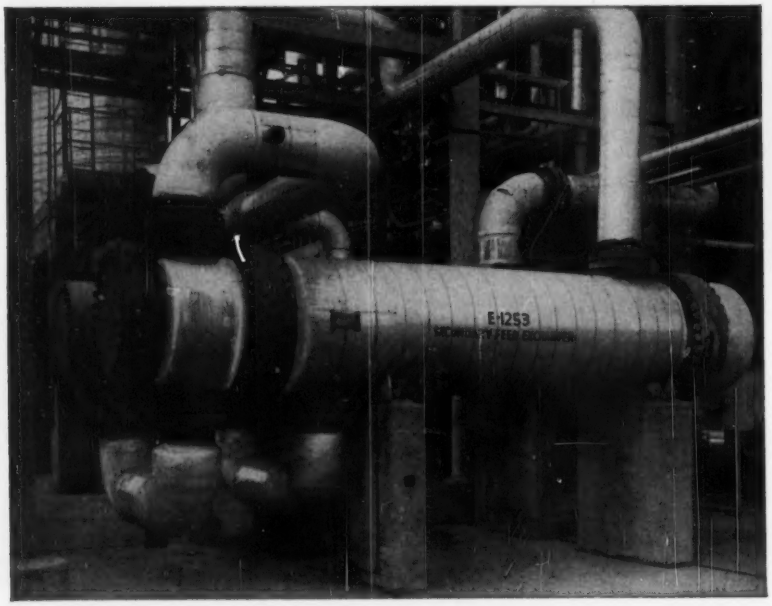
The Atlantic Refining Co. has awarded Pona Engineers a contract to build a $250,000 sulfur plant next to its refinery at Port Arthur, Texas. The plant will feed on the refinery's hydrogen sulfide waste gas and will produce 35 tons per day.

Wyandotte Chemicals Corp. will build a $3.5-million propylene oxide plant at Wyandotte, Mich. The company's Michigan Alkali Division will operate the plant. The facility should be on stream by mid-1962.

Ultra Chemical Works, Inc., a Witco Chemical Co. subsidiary, has put its $1.6-million synthetic detergent plant on stream at Chicago. The plant raises Ultra's detergent capacity by 60 percent.

Ethyl Corp. has doubled its capacity for principal antioxidants with the completion of expanded facilities at Orangeburg, S.C. The plant makes ortho-alkylated antioxidants.

Suntide Refining Co., subsidiary of Sunray Mid-Continent Oil Co. has started operation of a UOP Hydeal unit at Corpus Christi, Texas. The



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This Shell Oil Company installation, in their Deer Park Refinery, is typical of the many high-pressure, high-temperature alloy exchangers designed and fabricated by EFCO, for platformer feed to effluent exchangers.

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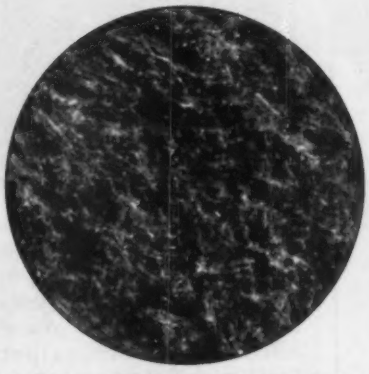
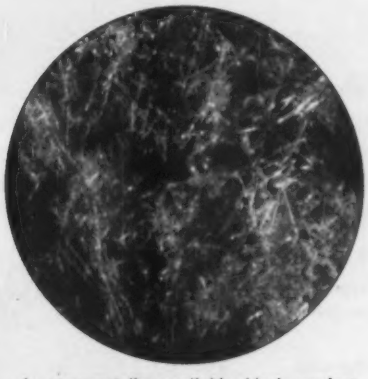
Another reason for Mono-Block's leadership is its high strength, minimizing loss due to breakage. And the tough, strong surface of Mono-Block can be directly finished with Baldwin-Ehret-Hill No. 1 or Super Powerhouse Cements in many instances without the need for applying wire mesh.

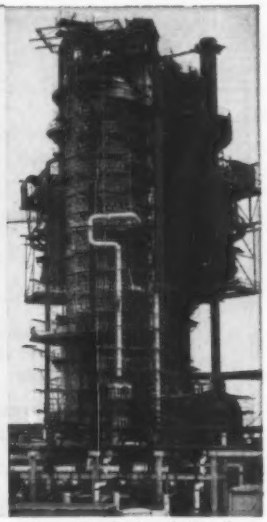
For detailed information about Mono-Block or any of the complete line of industrial insulations manufactured by Baldwin-Ehret-Hill, and the name of your nearby B-E-H qualified contractor, write to Department M-B, Baldwin-Ehret-Hill, Inc., 500 Breunig Ave., Trenton 2, N. J.



B-E-H Mono-Block magnified 10 times to show uniform, interlaced structure resulting from interlocked fibers.



A commercially available block product equally magnified to show the uneven texture.



Mono-Block insulates the world's largest catalytic cracking unit for Tidewater in Delaware.

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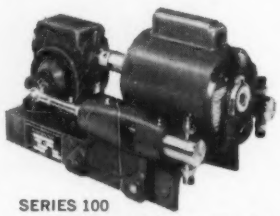

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Simplex models pump up to 13.10 gph at a maximum pressure of 1000 psi. Duplex models double that capacity.

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unit is producing 750-bpd of benzene. Designed and licensed by Universal Oil Products Co., the unit is integrated with Suntide's Platforming and Udex units. Toluene is separated by the Udex unit from aromatics produced by the Platforming unit. The toluene is hydrodealkylated in the Hydeal unit, using hydrogen produced by the Platformer.

A workman makes adjustments atop the tallest of six distillation towers at the anhydrous hydrazine plant built by Olin Mathieson Chemical Co. for the U.S. Air Force at Saltville, Va. Entire output of the facility will be used as a storable liquid fuel for the Titan II ICBM. (HYDROCARBON PROCESSING & PETROLEUM REFINER, Vol. 40, No. 5, Page 292.)

E. I. du Pont de Nemours & Co. has placed a polyethylene plant on stream at Victoria, Texas. The facility produces low-density polyethylene by a high-pressure process.

Union Texas Natural Gas Corp. has completed expansion of its Eunice, La., plant. The plant is the low temperature absorption type and has a

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In any engineering or construction project the real basis of economy is fast completion. Brown & Root has become legend for putting plants "on the line" ahead of schedule. This is possible because, with its own personnel and equipment, Brown & Root has the capability of a "turnkey" job. Every step is carefully controlled, from engineering through the manifold steps of construction and equipment installation. This "control" can be interpreted in fast, economical completion for you. If your organization is planning new construction or plant expansion, you'll profit by talking to the man from Brown & Root.

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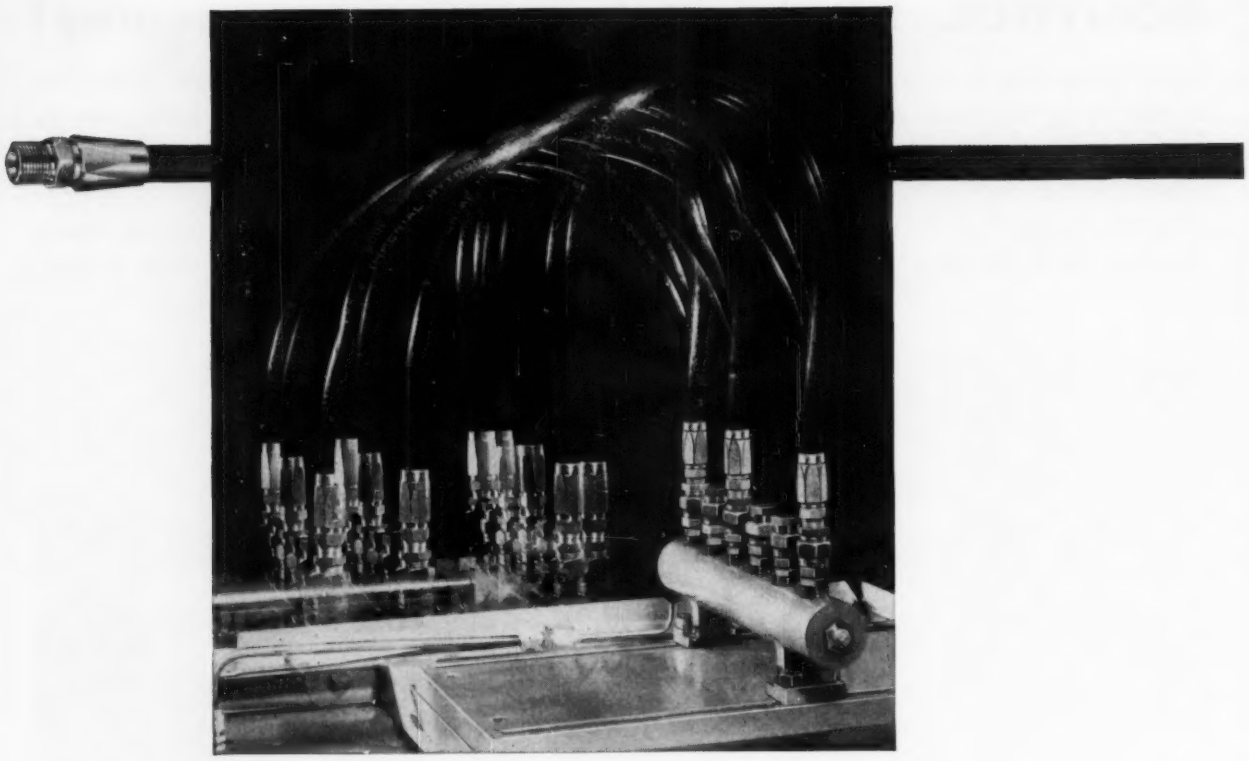


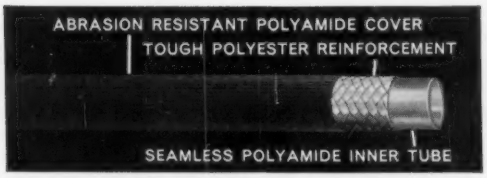
Hytron® hose delivers

7 TIMES THE FLEX LIFE

of wire braid hose

No need to pamper Hytron Hose. It lasts long, saves money on many applications. Hytron also has a wider range of uses than wire braid hose because it is more compatible to different fluids—mineral or synthetic fluids having a water or phosphate ester base.

Extra-long flex life and compatibility are *only two* of the outstanding advantages of Hytron Hose. For more information, see the next page. And write for detailed report and test results—Bulletin NEPR-500.



HYTRON

IMPERIAL EASTMAN

Imperial-Eastman Corporation General Offices: 6300 West Howard Street, Chicago 48, Illinois

Imperial-Eastman Corporation (Canada) Ltd., Barrie, Ontario • Imperial-Eastman, S.A., Apartado Postal 26544, Mexico 13, D.F.

HYTRON

solves problems, meets more needs, cuts costs

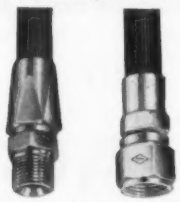
Hytron Hose, made with a seamless, extruded inner tube of special virgin polyamide, has a high-tensile-strength polyester braid reinforcement, plus extruded polyamide cover. Its strength compares with wire braid hose—its *additional* features open new design opportunities in hydraulic and pneumatic systems.

Compatibility=more uses

Hytron Hose is compatible with mineral or synthetic fluids having either water or phosphate ester base. Thus, you can use this *one* hose for *more* applications. Wherever you use S.A.E. 100R1 wire braid hose, Hytron should be considered.

Major advantages

- 7.2 times the flex life of wire braid hose.
- 2½ times more abrasion-resistance than rubber. High resistance to mildew, heat, sunlight, chemicals.
- Burst pressures from 9000 to 12,000 psi, depending on hose size and temperature. Temperature ranges from −40° to 250° F.
- Available in long lengths—up to 1000 ft. Sizes to ¾ in.
- 60% lighter weight than wire braid rubber hose.
- Low diametrical expansion.



Hytron Hose furnished as factory-made assemblies with permanently attached couplings, or with easy-to-install, re-usable couplings, in a wide range of sizes and styles.

HOSE

IMPERIAL — EASTMAN

Building . . .

capacity of 800 MMcfd of gas. Jointly owned with Texas Gas Exploration Corp. and operated by Runnels Gas Products Corp., the facility has recently processed over 700 MMcfd of gas.

W. R. Grace & Co.'s Brazilian subsidiary, Industria Quimica Products, Ftalicos, S.A., will expand its phthalic anhydride capacity at Ftalicos to make 240 tons per month. Grace also plans to construct a plant at Bogota, Colombia, to produce 60 tons per month of the chemical.

Idemitsu Kosan Oil Co. is seeking Japanese government approval to build an ethylene plant at Tokuyama. The 100,000-ton-per-year facility, due on stream in 1962, is estimated to cost $36 million. Japan's total ethylene capacity will be 392,000 tons annually upon completion of the project.

Polymer Corp., Ltd., has awarded a contract to Catalytic Construction of Canada, Ltd., for the engineering, procurement and construction of a multi-million-dollar polybutadiene plant at Sarnia, Ont. Construction will begin this summer, with completion before the end of 1962.

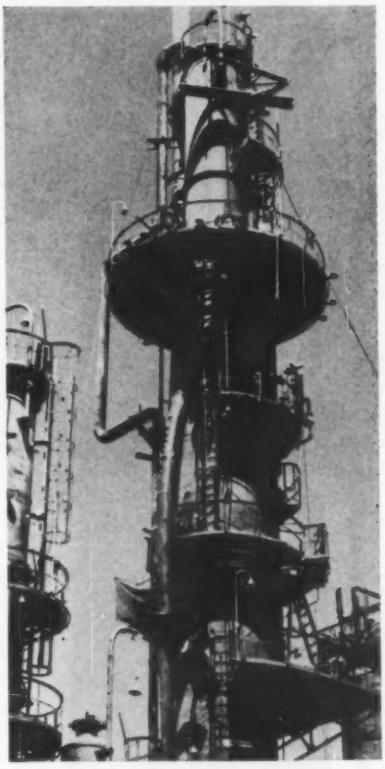
New Zealand's first oil refinery is expected to come on stream early in 1964. The 50,000-bpd plant will be at Marsden Point, Whangarei. When completed the refinery is expected to supply about 90 percent of New Zealand's annual petroleum products requirement. (HYDROCARBON PROCESSING & PETROLEUM REFINER, May 1961, page 306.)

Spain hopes to acquire financial and technological assistance soon from an undisclosed foreign company for a new refinery and petrochemical plant at its Calvo Ostelo shale oil refinery, Puertollano. A 22,000-bpd crude refining unit is being planned to supply basic products to the petrochemical plant, which would produce 275,000 tons per year.

Texaco, Inc., plans to construct a refinery at Puerto Limon, Costa Rica, to cost between $5 and $6 million. The 5,000-bpd refinery, first in Costa Rica, will probably run Venezuelan crude.

Jordan Refiner Completes New 7,500-bpd Plant

A 7,500-bpd refinery has been completed in Jordan by Jordan Petroleum Refinery Co., Ltd., Amman. The plant, which receives Aramco crude oil from the Trans Arabian pipe line, produces gasolines, kerosine, diesel fuel, fuel oil, bitumen and LPG.



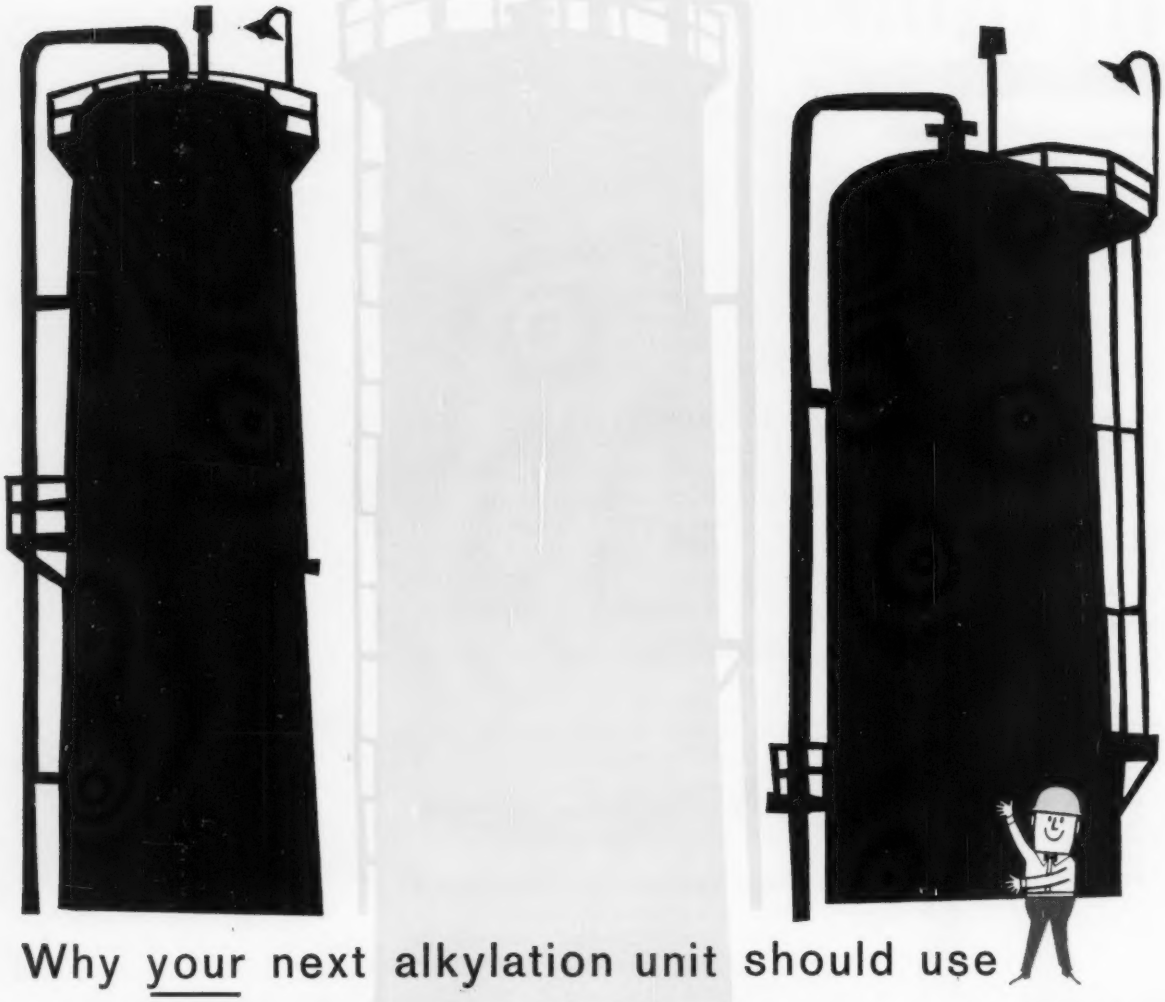
Cat cracker at Jordan plant.

Located in the center of the major Jordan petroleum market, the facility includes a topping unit, cat cracker, cat reformer, asphalt blowing unit, gasoline and kerosine sweetening unit and a liquid gas recovery unit.

Soviet Union has signed a revised agreement with India concerning refining facilities being built at Barauni, India. The revision resulted from India's objections to Russia's original contract. The Barauni plant is expected to be on stream by December 1962. Its initial capacity will be 20,000 bpd, which will be expanded to 30,000 bpd by April 1963. The contract is worth about $30.5 million.

United Carbon France S.A., subsidiary of United Carbon Co., has completed a carbon black plant in Port Jerome, France, to produce 50 million pounds of furnace black per

For more data on advertised products, use cards, last page.



Why your next alkylation unit should use

HYDROFLUORIC ACID

Because anhydrous hydrofluoric acid is easily regenerated, you'll consume less catalyst per barrel of alkylate, lower your catalyst inventory and minimize spent acid problems. AHF lets you cool with water, reduces both initial and operating expense for cooling. And in addition to these economies, AHF gives you shorter reaction time and catalyst settling time, with minimum side reaction products. These advantages have been proved in operating alkylation units across the nation.

To help you cash in on AHF, Pennsalt provides expert, experienced technical aid. We'll show you how to handle, store and use AHF safely and economically . . . advise you on piping, pumps, valves and materials of construction . . . help you with employee training programs. See your Pennsalt representative or write for full information. Industrial Chemicals Division, PENNSALT CHEMICALS CORPORATION, Three Penn Center, Philadelphia 2, Pa.

Get this new HF handling and data book. Write for Bulletin S-148.

Pennsalt Chemicals®
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Industrial Chemicals Division

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FOREIGN SALES: INDUSTRIAL QUÍMICA PENNSALT, MEXICO CITY
PENNSALT INTERNATIONAL, PHILADELPHIA, PA.

Building . . .

year. Cost of the project was $5 million.

Norsk Koksverk, owned by the Norwegian government, plans to build an ammonia plant at Nord-Rana in northern Norway. To cost about $8.4 million, the facility will produce 50,000 metric tons per year. If a loan from the Norwegian Parliament goes through, construction will begin this year, with completion slated for 1963.

Karonite Chemical Co., formed by California Chemical Co. and two Japanese firms, plans to produce and sell lubricating oil additives and alkylphenols in Japan under a Cal Chemical license. The company will build a plant at Kawasaki to process about 2 million gallons of finished lube oil additives and about 500,000 gallons of alkylphenols. Cost of the plant, to go on stream in 1962, is estimated at $2 million.

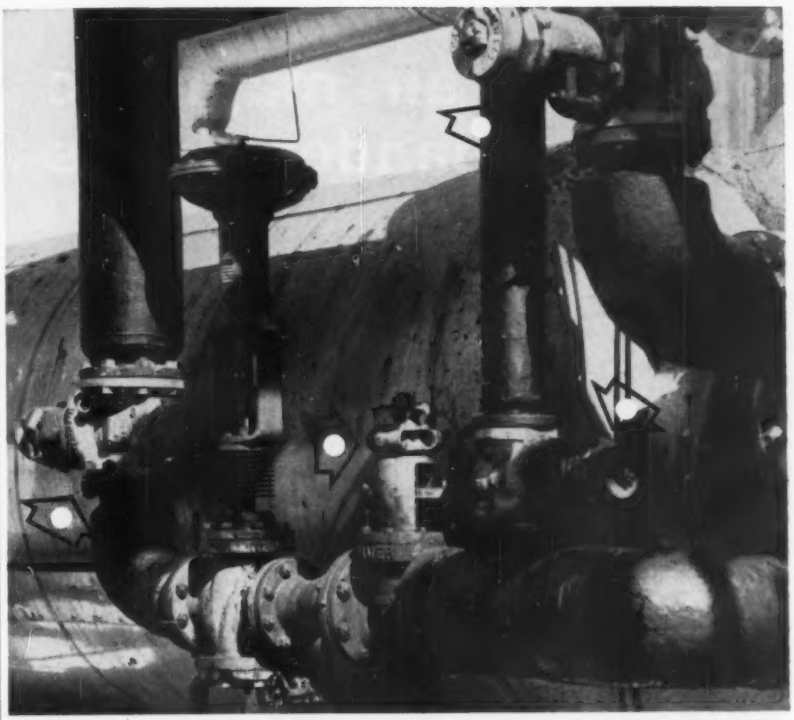
Maruzen Oil Co. of Japan is considering building a refinery at Urusan, South Korea. Daily capacity of the new facility would be 20 to 30,000 barrels. Oil consumption in South Korea last year was a little under 13,000 bpd.

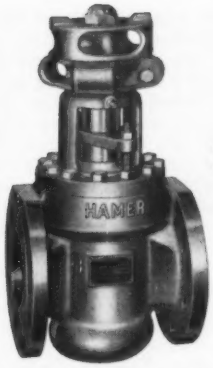
Hydrocarbon-Argentina, S.A., jointly owned by Minera Alumine of Argentina and Hydrocarbon Research, Inc., is building a $15-million refinery at San Lorenzo, Argentina. Initial capacity will be 8,000 to 11,000 bpd of high-octane gasoline and about 700 bpd of benzene.

Standard Oil Co. (New Jersey) has officially opened its new refinery in Norway. Norway's first oil refinery, the plant cost about $30 million.

Union Chimique Belge, S.A., is expanding its phthalic anhydride capacity by 5,000 tons yearly with the construction of a new plant at Schoonaarde, Belgium. The new facility will raise Union Chimique's annual phthalic capacity to 15,000 metric tons.

British Hydrocarbon Chemicals, Ltd., will build a petrochemicals complex at Baglan Bay, South Wales, to produce ethylene, propylene and butadiene. Stone & Webster Engi-





Hamer non-lubricated, non-sticking plug valve with gland packed stem seal. Standard opening. Sizes 1" through 12", in ASA 150 lbs. and ASA 300 lbs. series. Available in carbon steel and other metals to meet special corrosive and temperature conditions.

NON-STICKING NON-LUBRICATED

Hamer Plug Valves give outstanding performance in severe services

In such services as hot oil, LPG, hydrocarbons and others where lubrication is a source of trouble and expense the non-lubricated, non-sticking features of Hamer Plug Valves prove their real worth.

Non-lubricated means there is no danger of product contamination . . . no need for lubrication and maintenance. Non-sticking means easy operation at all times under high temperatures. A powerful screwjack lifts the plug off its seat for easy opening and closing.

You can depend on Hamer Plug Valves to give maximum service with minimum maintenance. Talk to your WECO, Chiksan or Hamer valve specialists about the valve requirements in your plant, or write for new and complete HAMER Valve Catalog 60.

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HV-3-61

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Division of CHIKSAN COMPANY *a subsidiary of* FOOD MACHINERY AND CHEMICAL CORPORATION

WECO UNIONS

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HAMER LINE BLIND VALVES

HAMER PLUG VALVES

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WECO COMPOUNDS

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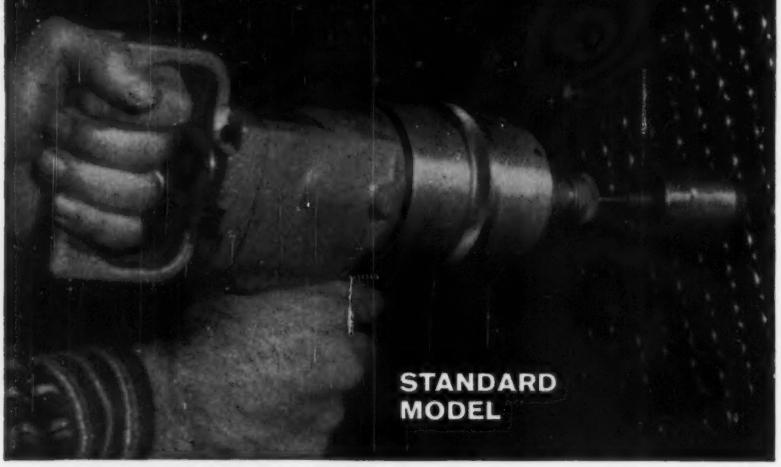
For more data on advertised products, use cards, last page.

ELLIOTT air magnetic tube expander drives

automatically controlled for fast, accurate tube rolling



Designed for faster, precision tube rolling, the standard model Elliott Air-Magnetic drive is setting new records for speed and accuracy. Some operators average 12 tubes per minute. Desired torque easily preset by rotating forward end of unit. No tools needed. Rolling stops when preset torque levels are reached. Includes trigger-controlled, explosion-proof air motor in single unit. Magnetic control, no springs. Balanced for easy handling. For tubes ¼ in. through 3 in. *Standard model* handles most jobs. *Heavy-duty* for higher torque.

ALSO Tube Expanders and Related Accessories

Elliott offers a complete line of tube expanders, with rotating, parallel, self-feeding rolls. Available in 4 types, ranging from ¼ in. to 3½ in. O.D. Also the Automatic Electric Control—an accurate torque-limiting device designed for tube expanding with any standard tapping motor.

WRITE for Bulletin Y-53

Elliott Tube Gage

Y1-3

ELLIOTT COMPANY

GENERAL OFFICES: JEANNETTE, PENNSYLVANIA

PLANTS AT: Jeannette and Ridgway, Pa.; Springfield, Ohio; Newark, N. J.

TURBINES • GENERATORS • MOTORS • COMPRESSORS • TURBOCHARGERS
DEAERATING HEATERS • EJECTORS • CONDENSERS • STRAINERS • TUBE CLEANERS

Building . . .

neering, Ltd., will construct the ethylene plant, and Lummus Co., Ltd., will build the ethylene dichloride facility. Completion is set for late 1962.

Gelsenberg Benzin A.G. is building aromatics extraction facilities at Gelsenkirchen-Horst, West Germany. The plant, using UOP's Udex process, will begin operations this fall, producing 23,000 to 47,000 tons per year of benzene.

Canadian Superior Oil of California plans to construct a gas processing plant near Didsbury, Alta., to handle 100,000 Mcfd of natural gas. The plant will also produce 4,700 bpd of stabilized condensate. Natural gas charge will come from the Harmattan-Elkton field. Operation is expected to get underway by January 1962.

Burma Oil Co., Ltd., is inviting construction bids for the expansion of its Syriam, Burma, refinery. The expansion program, to be completed early in 1963, will raise plant capacity from 5,300 bpd to more than 18,600 bpd.

Montecatini Societa Generale, Milan, Italy, will produce three newly developed synthetic rubbers at its $170-million petrochemical complex under construction at Brindisi, Italy.

Consumers' Cooperative Refinery Co. is expanding its crude processing and catalytic cracking facilities at its Regina, Sask., refinery. The expansion, to be handled by Refinery Engineering Co., Calgary, Alta., will increase the plant's capacity from 16,000 to 22,500 bpd. Estimated cost of the job is $750,000. Completion date is set for November.

Gelsenberg Benzin A.G. has started up its third UOP Platforming unit at its Gelsenkirchen Horst, West Germany, refinery. Also on stream is a second Unifiner for pretreatment of reformer feedstocks. The new 12,000-bpd Platforming unit is essentially a duplicate of the refiner's No. 2 Platforming unit. The unit is producing 95-97 research octane number gasoline unleaded. The Platforming and Unifining units were designed and licensed by Universal Oil Products Co.

HPI Construction Boxscore

Hydrocarbon Processing Plants

East

COMPANY	Plant Site	Project	Daily Capacity	Estimated Cost	Status	Probable Completion	Licensor	Engineering	Contractor
Air Products	Iselin, N.J.	Liquid Helium	.....	.....	Under Constr	.....	.....	.....	.....
Allied Chemical	Moundsville, W. Va.	Exp. Chlorinated Methane	.....	.....	.....	.....	.....	.....	.....
		Isocyanate	.....	.....	.....	Mid 1961	.....	.....	.....
American Rubber & Chemical	Louisville, Ky.	Polybutadiene, Polyisoprene Synthetic Rubber	30,000 tons/yr	.....	Under Constr Under Constr	Sept 1961 1961	Phillips Phillips	Staff Braun	..... Braun
Armour Agriculture Chemical	Cherokee, Ala.	*Urea	50 tons	.....	Under Constr	1962	.....	Kellogg	Kellogg
		*Ammonia	360 tons	.....	Under Constr	1962	.....	Kellogg	Kellogg
Ashland O&R	Ashland, Ky.	Naphthalene	75,000,000 lbs/yr	.....	Complete	.....	UOP	UOP/Staff	Badger Mfg
		Benzene	10,000,000 gal/yr	.....	Complete	.....	UOP	UOP/Staff	Badger Mfg
		Cat Reformer	12,000 bbls	$3 000,000	Complete	.....	.....	Staff	Blaw-Knox
		Vacuum Crude Distillation	32,000 bbls	.....	Complete	.....	.....	Staff	Badger Mfg
		*Toluene	10,000,000 gals/yr	.....	Under Constr	1961	UOP	Procon	Procon
		*Xylene	10,000,000 gals/yr	.....	Under Constr	1961	UOP	Procon	Procon
Atlantic Refining	Syracuse, N.Y.	Asphalt Terminal	2½ MM gallons storage	$1,000,000	Complete	.....	.....	Badger Mfg	Badger Mfg
	Philadelphia, Pa.	*Exp. Alkylation	7,500 bbls	.....	Engineering	Late 1961	.....	Kellogg	Staff
Avi Sun	New Castle, Del	Polypropylene Resin	75,000,000 lbs/yr	$30,000,000	Under Constr	July 1961	Staff	Bechtel	Bechtel
Collier Carbon & Chemical, Tidewater Oil	Delaware City Del.	Naphthalene	100,000,000 lbs/yr	.....	Under Constr	1961	Union Oil-Cal	.....	Catalytic
Du Pont	Belle, W. Va.	Methyl Methacrylate	.....	.....	Planning	1961	.....	.....	.....
	Memphis	Acrylonitrile	.....	.....	Under Constr	1961	.....	.....	.....
Firestone Tire & Rubber	Pottstown, Pa.	Polyvinyl Chloride	.....	.....	Complete	.....	Staff	Catalytic	Catalytic
Florida Southern Oil	Jacksonville, Fla.	Refinery	15,000 bbls	.....	Planning	.....	.....	.....	.....
Foster Grant	Leominster, Mass.	Plastic Polymers, Copolymers, Styrene Monomer, Molded Plastics	.....	$4,000,000	Planning	.....	.....	.....	.....
Goodrich-Gulf Chemicals	Institute, W. Va.	cis-Polybutadiene	20,000,000 lbs/yr	.....	Engineering	March 1962	Staff	Blaw-Knox	Blaw-Knox
Goodyear	Niagara Falls, N.Y.	Exp. Polyvinyl Chloride	.....	.....	Complete	.....	.....	.....	.....
Hatco Chemical	Fonds, N.J.	Phthalic Anhydride	22,000,000 lbs/yr	$2,500,000	Under Constr	Mid 1961	Sherwin-Williams	Badger Mfg	Badger Mfg
Hess Trading & Transport	Sewaren, N.J.	Exp. Refinery	35,000 bbls	.....	Planning	.....	.....	.....	.....
		Udex	.....	.....	Planning	.....	.....	.....	.....
		Catalytic Cracking	.....	.....	Planning	.....	.....	.....	.....
Heyden Newport Chemical	Fords, N.J.	Maleic Anhydride	24,000,000 lbs/yr	.....	Under Constr	1961	.....	S D	S D
		*Fumaric Acid	.....	.....	.....	.....	SD	.....	.....
Hooker Chemical	South Shore, Ky.	Phenol	.....	.....	Under Constr	Mid 1962	Staff	Blaw-Knox	Blaw-Knox
Monsanto Chemical	Logan Township, N.J.	Phthalic Anhydride	.....	.....	Under Constr	1961	Sherwin-Williams	Badger Mfg	Badger Mfg
Novamont	Neal, W. Va.	Isotactic Polypropylene, Other Petrochemicals	22,000,000 lbs/yr	.....	Under Constr	1961	Monte-catini	Staff	Staff
Olin Mathieson	Saltville, Va.	Hydrazine	.....	$14,000,000	Under Constr	1961	.....	McKee	McKee
Pittsburgh Chemical	Neville Island, Pa.	*Exp. Vinyl Plasticizers	.....	.....	Engineering	Jan 1962	.....	Staff	Staff
Quaker State Oil Ref.	St. Marys, Va.	*Propane Deresining	700 bbls	.....	Engineering	.....	.....	Foster Wheeler	Foster Wheeler
Reichhold Chemicals	Tuscaloosa, Ala.	Formaldehyde	35,000,000 lbs/yr	.....	Planning	.....	Staff	Staff	Staff
		Phenol	.....	$2,500,000	Under Constr	Late 1961	Staff	Staff	Staff
Shell Chemical	Woodbury. N.J.	Polypropylene	.....	.....	Under Constr	1962	Shell	Braun	Braun
Sun Oil	Marcus Hook, Pa.	Automatic Tank Gauging	.....	$428,000	Under Constr	1961	.....	Staff	Staff
		Crude Blending	.....	$230,000	Under Constr	1961	.....	Staff	Staff
SunOlin Chemical	Claymont. Del.	Ethylene	685,000 lbs	$17,000,000	Under Constr	Jan 1962	.....	Lummus	Lummus
		Ethylene Oxide	164,000 lbs	$3,000,000	Under Constr	Jan 1962	Shell	Lummus	Lummus
		Carbon Monoxide	1,000,000 scf	$2,500,000	Engineering	Jan 1962	.....	Air Products/ Kellogg	Air Products/ Kellogg
		Hydrogen	12,000,000 scf						
Tennessee Corp.	East Tampa, Fla.	Ammonia	100,000 tons/yr	$13,000,000	Planning	Early 1962	.....	.....	.....
Tidewater Oil, Air Products	Delaware City, Del.	*Oxo Alcohols	90,000 lbs	.....	Planning	1962	.....	.....	.....
Union Carbide	Institute, W. Va.	*Phthalic Anhydride	50,000,000 lbs/yr	.....	Engineering	1962	Sherwin-Williams	Badger	.....
U.S. Steel	Clairton, Pa.	Tar Distillation	.....	.....	Under Constr	1961	.....	McKee	McKee
U. S. Phosphoric Products	East Tampa, Fla.	Ammonia	300 tons	.....	Engineering	Late 1961	Chemico	Chemico	Chemico
Witco Chemical	Perth Amboy, N.J	*Phthalic Anhydride	30,000,000 lbs/yr	.....	Under Constr	.....	SD	SD	SD

Mid-Continent

COMPANY	Plant Site	Project	Daily Capacity	Estimated Cost	Status	Probable Completion	Licensor	Engineering	Contractor
Allied Chemical	South Point, Ohio	Exp. Methanol	50%	.....	.....	.....	.....	.....	.....
		Exp. Formaldehyde	35%	.....	.....	.....	.....	.....	.....
American Oil	Mandan, N.D.	Naphtha Desulfurizer	.....	.....	Under Constr	Summer 1961	.....	Staff	Parsons
	Whiting, Ind.	Alkylation	11,400 bbls	.....	Complete	.....	.....	Bechtel	Bechtel
		C O Boiler	.....	.....	Complete	.....	.....	Babcock & Wilcox	Staff
	Wood River, Ill.	LPG Treating	.....	.....	Under Constr	Fall 1961	.....	Staff	Staff
	Sugar, Creek, Mo.	*Crude Distillation	70,000 bbls	.....	Engineering	Summer 1962	.....	Parsons	Parsons
Amoco Chemicals	Joliet, Ill.	Exp. Esters	.....	.....	Engineering	Summer 1961	Staff	Tears	Staff
		Trimellitic Anhydride	.....	.....	Under Constr	Summer 1961	.....	S D	S D
Borden Chemical	Illiopolis. Ill.	Polyvinyl Chloride	40,001,000 lbs/yr	$4,000,000	Planning	.....	.....	.....	.....
California Chemical	Ft. Madison, Iowa	Ammonia	300 tons	$22,000,000	Under Constr	Late 1961	.....	Staff/Bechetl/ C & I	Bechtel/C&I
		Nitric Acid	250 tons						
		Ammonium Nitrate	150 tons						
		Complex Fertiliser	600 tons						
Champlin Oil & Refining	Enid, Okla.	Delayed Coker	4,000 bbls	$1,500,000	Under Constr	Oct 1961	.....	Staff/Fluor	Staff/Fluor

*First appearance in tabulation.

HPI CONSTRUCTION BOXSCORE—*Continued*

COMPANY	Plant Site	Project	Daily Capacity	Estimated Cost	Status	Probable Completion	Licensor	Engineering	Contractor
Cooperative Farm Chemicals	Lawrence, Kan.	Ammonia	100 tons	$5,400,000	Under Constr	.....	.....	Chemico	Chemico
		Urea	30 tons						
Dow Chemical	Midland, Mich.	Exp. Styrene Monomer	.....	.....	Under Constr	.....	.....	.....	.....
	Bay City, Mich.	Polypropylene	.....	.....	Under Constr	.....	.....	.....	.....
DX Sunray	Tulsa, Okla.	Crude Distillation	85,000 bbls	$6,500,000	Under Constr	Sept 1961	.....	Foster Wheeler	Foster Wheeler
		Hydeal	1,000 bbls	$1,100,000	Under Constr	Summer 1961	UOP	UOP	Foster Wheeler
Ben Franklin Refining	Ardmore, Okla.	*Crude	25,000 bbls	.....	Under Constr	Fall 1961	.....	Tears	Tears
Goodyear Tire & Rubber	Akron, Ohio	Exp. Nitrile & Latex	.....	.....	Under Constr	1961	.....	.....	.....
Hunt Oil	Tioga, N.D.	Gasoline	9MMcf	.....	Planning	Nov 1961	.....	.....	.....
Koppers	Cleveland, Ohio	Sulfur Recovery	6 tons	$115,000	Complete	.....	Pan American	Tears	Tears
Mack Oil	Healdton, Okla.	Gasoline	6MMcf	.....	Engineering	July 1961	.....	Dresser	Dresser
Monsanto Chemical	Monsanto, Ill.	Exp. Phenol	.....	.....	Under Constr	Mid 1961	.....	.....	.....
	El Dorado, Ark.	Urea Distillation	.....	.....	Under Constr	.....	.....	Chemico	Chemico
	St. Louis	Exp. Maleic Anhydride	20,000,000 lbs/yr	.....	Under Constr	.....	.....	SD	SD
Murphy	Superior, Wis.	Fluid Cat Cracking	5,000 bbls	.....	Engineering	Dec 1961	UOP	Sweco	Sweco
		Alkylation	1,000 bbls	.....	Engineering	Dec 1961	UOP	Sweco	Sweco
National Cooperative Refinery	McPherson, Kan.	Delayed Coker Revamp	.....	$1,200,000	Engineering	Fall 1961	.....	Staff/UOP	Procon
Northern Gas Prod.	Bushton, Kan.	Hydrocarbons Recovery	896 MMcf	$10,000,000	Under Constr	Aug 1961	.....	Fluor	Fluor
Ohio Oil	Robinson, Ill.	Fluid Cat Cracking Revamp	12,000-18,000 bbls	$1,250,000	Under Constr	1961	UOP	UOP	Staff
Oil Chem.	Lignite, N.D.	Gasoline	20 MMcf	$1,750,000	Engineering	1961	.....	Pona	.....
Oxo Chemicals	Portsmouth, Ohio	Oxo Alcohol	.....	$100,000,000	Engineering	1962	.....	Fluor	Fluor
Pennsalt Chemical	Wyandotte Mich.	Alkylalkanolamines	7.5 MM lbs/yr	.....	Under Constr	.....	Staff	Catalytic	Catalytic
		*Exp. Alkylamines	.....	.....	Under Constr	Feb 1962	.....	Blaw-Knox	Blaw-Knox
Phillips Chemical	E. St. Louis, Ill.	Ammonia Storage	15,000 tons	.....	Under Constr	1961	.....	Girdler	Girdler
Pure Oil	Lemont, Ill.	*BTX	70,000 gals	.....	Under Constr	Late 1961	UOP	UOP/Procon/ Staff	Procon
RJ Oil & Refining	Princeton, Ind.	Unifiner	1,700 bbls	.....	Under Constr	.....	.....	UOP	Staff
		Crude Distillation	5,000 bbls	.....	Under Constr	.....	.....	UOP	Staff
		Platformer	1,700 bbls	.....	Under Constr	.....	.....	UOP	Staff
		*Thermal Cracking	2,200 bbls	.....	Under Constr	Early 1962	.....	UOP	Staff
Shell Chemical	Marietta, Ohio	Synthetic Rubber	.....	.....	Under Constr	.....	Shell	Braun	Braun
Shell Oil	Wood River, Ill.	Catalytic Reformer & Offsite Facilities	25,000 bbls	$15,000,000	Complete	.....	.....	McKee/Parsons	McKee/Parsons
Signal Oil & Gas	Tioga, N.D.	*Exp. Amine, Natural Gas Liquids	80 MMcf	$1,500,000	Engineering	1961	.....	.....	.....
Sinclair Refining	Wood River, Ill.	*Heptene	265 bbls	.....	Under Constr	Fall 1961	.....	Procon	Procon
Skelly Oil	Minneola, Kansas	Gasoline	25 MMcf	.....	Complete	.....	.....	Dresser	Dresser
Solar Nitrogen	Joplin, Mo.	Ammonia	300 tons	$15,000,000	Complete	.....	.....	Kellogg	Kellogg
		Urea	150 tons		Under Constr	Oct 1961	Stamicarbon	McKee/Stamicarbon	McKee
		Solutions Blending	25,000 tons/yr	.....	Engineering	Nov 1961	.....	Stand-Ohio	Nofsinger
Standard-Ohio	Toledo, Ohio	Isocracker	7,500 bbls	$4,000,000	Engineering	Late 1961	Cal Research	Parsons	Parsons
	Cleveland, Ohio	*LPG Storage	.....	$560,000	Under Constr	Fall 1961	.....	Staff	Staff
		*Gasoline Blending	.....	$692,000	Engineering	Fall 1961	.....	Staff	.....
Sun Oil	Toledo	Propane Deasphalting	9,500 bbls	$3,600,000	Complete	.....	.....	Staff/Foster Wheeler	Foster Wheeler
		Naphthalene	100,000,000 lbs/yr	$8,000,000	Under Constr	Late 1961	.....	Staff	Kellogg
		Automatic Tank Gauging	.....	$200,000	Under Constr	1961	.....	Staff	Staff
Texaco	Beaver County, Okla.	*Exp. Gasoline	to 70 MMcf	.....	Engineering	Oct 1961	.....	Olsen	Olsen
Union Carbide	Marietta, Ohio	Bisphenol-A	25,000,000 lbs/yr	.....	Under Constr	1961	.....	.....	.....
Warren Petroleum	Mocane, Okla.	Exp. Gasoline	to 200 MMcf	.....	Complete	.....	.....	Dresser	Dresser

Southwest

COMPANY	Plant Site	Project	Daily Capacity	Estimated Cost	Status	Probable Completion	Licensor	Engineering	Contractor
Allied Chemical	Orange, Texas	Polyethylene Glycol	.....	.....	Under Constr	.....	.....	.....	.....
	Baton Rouge, La.	Polyethers	20,000,000 lbs/yr	.....	.....	1961	.....	.....	.....
Aluminum Co. of America	Point Comfort, Texas	Exp. Natural Gasoline	150 MMcf	.....	Under Constr	1961	.....	Olsen	Olsen
American Oil	Texas City	Crude Distillation	150,000 bbls	.....	Under Constr	Fall 1961	.....	Kellogg	Kellogg
		Cat Cracker	47,600 bbls	.....	Under Constr	Fall 1961	.....	Kellogg	Kellogg
		Cooling Water	.....	.....	Under Constr	Aug 1962	.....	Tears	Tears
		Alkylation	14,600 bbls	$7,000,000	Under Constr	Fall 1961	.....	Fluor	Fluor
		Isomerization, Butane Splitting	12,600 bbls						
		*Delayed Coking Revamp	.....	.....	Engineering	Nov 1961	.....	Tellepsen	Tellepsen
		*Cat Cracker Revamp							
		*Crude Charge	.....	.....	Under Constr	Aug 1961	.....	Tears	Tears
American Petrofina	Wichita, Falls, Texas	Refinery Gas	.....	$320,000	Complete	.....	UOP	Tears	Tears
Amoco Chemicals	Texas City	Petroleum Resins	.....	.....	Under Constr	1961	.....	Bechtel	Bechtel
Atlantic Refining	Port Arthur, Texas	Sulfur	35 tons	$250,000	Engineering	Sept 1961	Pan American	Pona	Pona
		*Aromatics Prefractionation	5,500 bbls	.....	Engineering	Late 1961	.....	Parsons	Parsons
	George West, Texas	*Gasoline	90 MMcf	.....	Under Constr	Oct 1961	.....	Olsen	Olsen
California Chemical	Oak Point, La.	*Exp. Lube Oil Additives	2,400,000 gals/yr	$1,000,000	Under Constr	Mid 1961	.....	Staff	.....
Carbide & Carbon	Seadrift, Texas	Exp. Polyethylene	.....	.....	Engineering	.....	.....	B & R	.....
	Texas City	Exp. Ethylene Glycol	65 MMcf	.....	Planning	.....	.....	.....	.....
Carwin	Houston	Special Isocyanates	1,5000,000 lbs/yr	$1,000,000	Under Constr	1961	.....	Pona	Mundy Constr
Celanese	Bay City, Texas	Petrochemicals	.....	.....	Under Constr	Early 1962	Aldehyd	B & R	B & R
	Bishop, Texas	Acetal Copolymer	.....	.....	Under Constr	Early 1962	.....	B & R	B & R
		Exp. Butanol	.....	.....	Under Constr	1961	.....	Staff	.....
Cities Service	Lake Charles, La.	Udex Extraction, Orthoxylene Recovery	120,000,000 lbs/yr	$4,500,000	Complete	.....	UOP	Badger Mfg	Badger Mfg
Coastal Products	Corpus Christi, Texas	Delayed Coking	7,000 bbls	$3,000,000	Under Constr	.....	.....	Treco	Treco
Columbian Carbon	North Bend, La.	*Exp. Carbon Black	.....	.....	Under Constr	Aug 1961	Staff	Ford, Bacon & Davis	Ford, Bacon & Davis
Continental Oil	Lake Charles La.	Straight-Chain Primary Alcohols	50,000,000 lbs/yr	.....	Under Constr	1961	.....	Lummus	Lummus
		Exp. Natural Gasoline	to 150 MMcf	.....	Under Constr	1961	.....	Hudson	Hudson
Copolymer Rubber & Chemical	Baton Rouge, La.	Exp. Rubber	to 300,000,000 lbs/yr	$3,000,000	Complete	.....	.....	Staff	Staff
		Exp. Butadiene	to 55,000 tons/yr	$5,000,000	Under Constr	Sept 1961	Dow	Foster Wheeler	Foster Wheeler

*First appearance in tabulation.

HPI CONSTRUCTION BOXSCORE—*Continued*

COMPANY	Plant Site	Project	Daily Capacity	Estimated Cost	Status	Probable Completion	Licensor	Engineering	Contractor
Cosden Petroleum	Big Spring, Texas	Exp. Polystyrene	to 40,000,000 lbs/yr	.....	Under Constr	.....	Staff	Staff	Staff
		Exp. Benzene	600 bbls	$800,000	Complete	.....	Staff	Staff	Staff
		Chemical Polymers	2,500,000 gal/yr	$500,000	Under Constr	July 1961	.....	Staff	Staff
		Desulfurization	6 MMcf	$200,000	Complete	.....	.....	Graff	.....
		Ortho-Xylene	70,000,000 lbs/yr	.....	.....	1961	.....	.....	.....
		Revamp Propylene	2,500,000 gals/yr	.....	Engineering	July 1961	.....	Staff	Staff
Crown Central Pet.	Pasadena, Texas	*Udex, Reformer Revamp	.....	$3,750,000	Under Constr	Late 1961	UOP	Tellepsen	Tellepsen
		*Orthoxylene	.....	.....	Under Constr	Aug 1961	UOP	Tellepsen	Tellepsen
	Houston	Detol	17,000,000 gal/yr	.....	Under Constr	Summer 1961	Houdry	Catalytic	Catalytic
Diamond Alkali	Deer Park, Texas	Acetylene	.....	.....	Under Constr	Early 1962	Montecatini	Braun	Braun
		Ammonia	.....	.....	Engineering	Early 1962	.....	.....	.....
Dow Chemical	Freeport, Texas	Acrylonitrile	.....	.....	Under Constr	1961	.....	Staff	.....
		Exp. Ethylene 67%	.....	.....	Under Constr	1961	.....	Staff	.....
		Exp. Styrene Monomer	.....	.....	Complete	.....	.....	Staff	.....
		*Styrene-Butadiene Latexes	.....	.....	Complete	.....	.....	.....	.....
	Plaquemine, La.	Polyethylene II	.....	$6,000,000	Under Constr	Mid 1962	.....	Staff	.....
Du Pont	Orange, Beaumont, Tex.	Polyethylene	.....	.....	Under Constr	.....	.....	.....	.....
		Caprolactum	50,000,000 lbs/yr	.....	Under Constr	.....	.....	Staff	Staff
		Acrylonitrile	.....	.....	Under Constr	Spring 1962	Staff	Staff	Staff
El Paso Natural Gas	Pecos County, Texas	Gas Treating	50 MMcf	.....	Planning	.....	.....	.....	.....
	Odessa, Texas	Ethylene	150,000,000 lbs/yr	.....	Engineering	Late 1961	.....	UOP/Fish	Fish
		Benzene	15,000,000 gals/yr	.....	.....	July 1961	UOP	UOP/Nofsinger	Ref-Chem
Esso Standard	Baton Rouge, La.	Exp. Butyl Rubber, Stage II	18,000 tons/yr	$8,000,000	Under Constr	Mid 1961	.....	.....	.....
Firestone	Orange, Texas	Polybutadiene, Polyisoprene	100 tons	$8,000,000	Complete	.....	.....	Day & Zimmerman	Day & Zimmerman
Foster Grant	Baton Rouge, La.	*Styrene Monomer	180,000,000 lbs/yr	.....	Under Constr	1961	Staff	Staff	Staff
	Beaumont, Texas	*Polyethylene	.....	.....	Under Constr	Summer 1961	SD	SD	SD
Gillring Oil	Fashing, Texas	*Sulfur Recovery	10 tons	.....	Under Constr	Aug 1961	.....	Graff	Graff
Goliad/Union Oil of Cal.	Ascension Parish, La.	LPG Fractionation	20,000 bbls	.....	Under Constr	.....	.....	B & R	Mid-Valley
Goliad	Lavaca County, Texas	*Exp. Gasoline	to 255 MMcf	.....	Under Constr	Oct 1961	.....	Olsen	Olsen
Goodrich Gulf Chemicals	Port Neches, Texas	Polyolefins, High-Density Polyethylene	13,000,000 lbs/yr	.....	Under Constr	1961	Ziegler	Parsons	Parsons
Goodyear	Beaumont, Tex.	Polyisoprene, Isoprene Polybutadiene	30,000–40,000 tons/yr	.....	Under Constr	Jan 1962	.....	SD	SD
	Houston	Special Latex Finishing	.....	.....	Complete	.....	.....	B & R	.....
W. R. Grace	Baton Rouge, La.	*Polyethylene	.....	.....	Under Constr	Summer 1961	.....	.....	.....
	Big Spring, Texas	*Anhydrous Ammonia	60,000 tons/yr	.....	Under Constr	Spring 1962	.....	Foster Wheeler	Foster Wheeler
Gulf Oil	Port Arthur	Delayed Coker	550 tons	.....	Under Constr	Summer 1961	.....	Kellogg	Kellogg
		Lube Oil Hydrogenation	13,000 bbls	.....	Complete	.....	.....	Bechtel/Staff	Bechtel
Hercules Powder	Lake Charles, La.	Polypropylene	120,000,000 lbs/yr	.....	Under Constr	1961	Staff	.....	.....
Houston Chemical	Beaumont, Texas	Ethylene Glycol, Ethylene Oxide	8–12,000,000 gals/yr	$12,000,000	Under Constr	1961	SD	SD	SD
		TEL-TML	.....	.....	Uader Constr	1961	.....	Singmaster & Breyer	Singmaster & Breyer
J.M. Huber	Baytown, Texas	Furnace Blacks	170,000 lbs	.....	Complete	.....	.....	Staff	B & R
Humble	Baytown, Texas	Exp. Lub Hydrofiner, Dewaxing, Extraction	6,500 bbls	.....	Complete	.....	.....	Fluor	Staff
Lyda Hunt-Herbert Trusts	Refugio County, Texas	Gasoline	30 MMcf	.....	Under Constr	1961	.....	Stearns-Roger	Stearns-Roger
Hunt Petroleum	Kinder, La.	Gasoline	24 MMcf	$900,000	Complete	.....	.....	Tears	Tears
W H. Hunt Trust	Aransas County, Texas	Compressor	.....	.....	Complete	.....	.....	Tears	Tears
Mobil Chemical	Beaumont, Texas	Ethylene	380,000,000 lbs/yr	.....	Under Constr	1961	.....	Kellogg	Kellogg
		Exp. Polyethylene	12,500 bbls	$2,500,000	Planning	.....	.....	.....	.....
		Delayed Coker	.....	.....	Under Constr	.....	.....	Lummus	Lummus
Monsanto Chemical	Gulf Coast	Styrene Monomer	200,000,000 lbs/yr	$30,000,000	Planning	1961	.....	.....	.....
	Chocolate Bayou, Texas	*Ethylene	500,000,000 lbs/yr	.....	Engineering	1962	.....	Bechtel/Staff	Bechtel/Staff
		*Benzene	42,000,000 gals/yr	.....	Engineering	1962	.....	Bechtel/Staff	Bechtel/Staff
		*Naphthalene	50,000,000 lbs/yr	.....	Engineering	1962	.....	Bechtel/Staff	Bechtel/Staff
Pan American Pet.	North Cowden, Texas	Exp. Gas Compression	.....	.....	Under Constr	.....	.....	Staff	B & R
	Old Ocean, Texas	Exp. Refinery	.....	.....	Engineering	.....	.....	B & R	B & R
Petroleum Chemicals	Lake Charles, La.	Exp. Ethylene	100,000,000 lbs/yr	.....	Planning	.....	.....	Lummus	.....
Petro-Tex Chemical	Houston, Texas	*Maleic Anhydride	30,000,000 lbs/yr	.....	Under Constr	.....	SD/Staff	SD	SD
Phillips Chemical	Borger, Texas	Exp. Synthetic Rubber	20,000 tons/yr	.....	Under Constr	.....	.....	.....	.....
		Cis-4 Polybutadiene	20,580 tons/yr	.....	Complete	.....	.....	Staff	Staff
	Orange, Texas	Carbon Black	60,000,000 lbs/yr	.....	Under Constr	1961	.....	Staff	Stearns Rogers
	Pasadena, Texas	Exp. Polyolefins	to 100,000,000 lbs/yr	.....	Complete	.....	.....	.....	.....
	Sweeny, Texas	Ethylene	160,000,000 lbs/yr	.....	Under Constr	Mid 1961	.....	Braun	Braun
Phillips Petroleum	Borger, Texas	Heavy Oil Cat Cracking	25,000 bbls	.....	Complete	.....	.....	Kellogg	Kellogg
	Sweeny, Texas	Exp. Natural Gas Liquids	.....	.....	Complete	.....	.....	Braun	Braun
		Benzene	22,000,000 gals/yr	.....	Under Constr	1961	.....	Procon	Procon
	Stephenville, Texas	Natural Gasoline	25,000 MMcf	.....	Under Constr	1961	.....	Staff	Staff
	Abbeville, La.	Natural Gas Liquids	45,000 MMcf	.....	Under Constr	1961	.....	Stearns Roger	Stearns Roger
Pure Oil, Atlantic Refining	Nederland, Texas	BTX	137,000 gals	.....	Under Constr	Dec 1961	UOP	UOP/Kellogg/ Staff	Kellogg
Rexall Chemical	Odessa, Texas	Polyethylene	120,000,000 lbs/yr	$20,000,000	Under Constr	Fall 1961	.....	Fluor	Fluor
Sid Richardson Carbon	Big Spring, Tex.	Furnace Black	50,000,000 lbs/yr	.....	Under Constr	Mid 1961	United Carbon	B & R	B & R
Shell Oil	Sheridan Texas	Gas Cycling	150 MMcf	$1,000,000	Planning	.....	.....	.....	.....
		Amine	.....	$125,000	Engineering	July 1961	.....	Pona	.....
	Bryans Mill, Cas County, Texas	*Gas Sweetening, Condensate Stabilization	30 MMcf	.....	Engineering	Late 1961	.....	B & R	B & R
		*Sulfur Recovery	120 tons						

*First appearance in tabulation.

HPI CONSTRUCTION BOXSCORE—*Continued*

COMPANY	Plant Site	Project	Daily Capacity	Estimated Cost	Status	Probable Completion	Licensor	Engineering	Contractor
Shell Oil (Cont.)	Ysceloskey, La.	*Gas Processing	600 MMcf	.....	Engineering	Early 1962	.....	B & R	B & R
Shell Chemical	Norco, La.	Acrolein	.....	.....	Complete	.....	.....	.....	.....
		Glycerine	.....	$4,500,000	Complete	.....	.....	Staff	Parsons/Fluor
Signal Oil & Gas	Houston	Fluid Cat Cracker & Light Ends	.....	.....	Complete	.....	.....	B & R	B & R
		Crude, Vacuum, Vis-breaker, Light Ends	60,000 bbls	.....	Under Constr	Late 1961	.....	B & R	B & R
		Exp. Refinery	.....	.....	Planning	.....	.....	.....	.....
Sinclair-Koppers	Houston	Ethylbenzene, Styrene	70,000,000 lbs/yr	$6,500,000	Under Constr	Mid 1961	Cosden	Badger Mfg	Badger Mfg
Sinclair Refining	Houston	Crude Still	60,000 bbls	.....	Under Constr	Mid 1961	.....	Braun	Braun
		Lube Oil	.....	.....	Complete	.....	.....	Braun	Braun
		Ortho-Xylene	70,000,000 lbs/yr	.....	Complete	.....	.....	Braun	Braun
South Louisiana Production	Jeanerette, La.	Butane, Propane, Other LPG	.....	.....	Under Constr	.....	.....	.....	.....
Suntide Refining	Corpus Christi, Texas	Hydeal	1,000 bbls	$800,000	Under Constr	1961	UOP	UOP	Staff
		Ethylbenzene	30,000,000 lbs/yr	$1,500,000	Under Constr	Mid 1961	Cosden	Badger Mfg	Badger Mfg
		Alkar-Styrene	60,000,000 lbs/yr	.....	Engineering	Early 1962	UOP	UOP	Parsons
		*Styrene	.....	.....	Under Constr	1962	.....	Parsons	Parsons
		*Paraxylene							
Tenneco Oil	Chalmette, La.	Udex Aromatics Extraction	3,100 bbls	.....	Under Constr	Mid 1961	UOP	UOP/Badger Mfg.	UOP/Badger Mfg
		Ethylbenzene	20 MM lbs/yr	.....	Under Constr	Mid 1961	Cosden	Badger Mfg	Badger Mfg
		Catalytic Reforming	6,000 bbls		Under Constr	Mid 1961	Houdry	Houdry/Bechtel	Bechtel
		Orthoxylene	20,000,000 lbs/yr		Under Constr	Mid 1961		Bechtel	Bechtel
	Palacios, Texas	Natural Gasoline	55 MMcf	.....	Complete	.....	.....	Olsen	Olsen
Texaco	Port Arthur, Texas	Hydrotreater	12,000 bbls	.....	Under Constr	1961	.....	Fluor	Fluor
		*Benzene	30,000,000 gals/yr	.....	Engineering	1962	.....	.....	.....
	Lamesa, Texas	Natural Gasoline	10 MMcf	$700,000	Under Constr	1961	.....	Pona	Pona
Texas Eastman	Longview, Texas	Polypropylene	20,000,000 lbs/yr	.....	Complete	.....	.....	Staff	Hudson
Texas-U.S. Chemical	Port Neches, Texas	Polybutadiene	20,000 tons/yr	.....	Planning	1962	.....	.....	.....
Union Carbide	Seadrift, Texas	Ester & Alcohol	100,000,000 lbs/yr	.....	Engineering	.....	.....	.....	.....
		Exp. Petrochemicals	.....	.....	Under Constr	.....	.....	Staff	B & R
	Brownsville, Texas	Chemical Solvents, Intermediates	.....	$2,500,000	Under Constr	1961	.....	.....	B & R
U. S. Industrial Chemicals	Houston	Polyethylene	60,000,000 lbs/yr	.....	Planning	Late 1962	.....	.....	.....
Warren Petroleum	Fashing, Texas	Sulfur	50 tons	.....	Complete	.....	.....	Graff Eng	Delta Eng
	Odessa, Texas	*Gas Products	200,000 Mcf	.....	Planning	1962	.....	.....	.....
		*Sulfur	50 tons	.....	Planning	1962	.....	.....	.....
Western Nat. Gas	Brownsville, Texas	Refinery Revamp	3,500 bbls	.....	Complete	.....	.....	.....	Staff
Wickett Refining	Wickett, Texas	Platformer	1,500 bbls	$350,000	Planning	.....	UOP	J C Hinds	J C Hinds

Rocky Mountain

COMPANY	Plant Site	Project	Daily Capacity	Estimated Cost	Status	Probable Completion	Licensor	Engineering	Contractor
American Oil	Casper, Wyo.	*Crude Distillation	37,000 bbls	.....	Under Constr	Fall 1961	.....	Bechtel	Bechtel
El Paso Natural Gas	Lea County, N. M.	Ethane Extraction	650 MMcf	.....	Planning	Late 1961	.....	.....	.....
Farmers Union Central Exchange	Laurel, Mont.	*Fractionator & Stripper Column	.....	$110,000	Under Constr	1961	UOP	UOP	Sweco
Gas Processors	Garland Field, Wyo.	Sulfur Recovery	14 tons	$155,000	Complete	.....	Pan American	Tears	Tears
	Rozet Field, Wyo.	Natural Gasoline	20,000 gal	.....	Complete	.....	.....	Staff	Staff
	Patrick Draw Field, Wyo.	Natural Gasoline	20,000 gal	.....	Under Constr	1961	.....	Staff	Staff
	South Elk Basin Field, Wyo.	Exp. Natural Gasoline	8,000 Mcf	$160,000	Under Constr	1961	.....	Staff	Staff
N. C. Ginther	Newcastle, Wyo.	*Gasoline	5 MMcf	.....	Engineering	Aug 1961	.....	Russell Eng	Staff
Husky Oil	Cody, Wyo.	Refinery	9,000 bbls	$5,400,000	Complete	.....	UOP	UOP	Sweco
Standard-Indiana	Casper, Wyo.	Crude Distillation	37,000 bbls	.....	Under Constr	1961	.....	Bechtel	Bechtel
Susquehanna Western	Riverton, Wyo.	Exp. Sulfuric Acid	to 75,000 tons/yr	.....	Under Constr	.....	.....	.....	.....

West Coast

COMPANY	Plant Site	Project	Daily Capacity	Estimated Cost	Status	Probable Completion	Licensor	Engineering	Contractor
Borden Chemical	San Francisco	Formaldehyde	22,500 tons/yr	.....	Under Constr	.....	.....	.....	.....
Collier Carbon & Chemical, Tidewater Oil	Los Angeles	Naphthalene	50,000,000 lbs/yr	.....	Planning	Early 1962	Union Oil-Cal	.....	.....
Continental Carbon	Bakersfield, Calif.	Carbon Black	30,000,000 lbs/yr	$2,500,000	Under Constr	Mid 1961	.....	Parsons	Parsons
Dow Chemical	Torrance, Cal.	Polypropylene	.....	.....	Under Constr	1961	.....	.....	.....
	Kalama, Wash.	Phenol	36,000,000 lbs/yr	.....	Under Constr	Early 1962	.....	.....	.....
Golden Eagle Ref.	Torrance, Calif.	Exp. Refinery	to 30,000 bbls	$35,000,000	Planning	Mid 1963	.....	UOP	.....
Hercules Powder	Hercules, Calif.	Methanol	8,000,000 gals/yr	.....	Under Constr	1961	.....	.....	.....
		Formaldehyde	50,000,000 lbs/yr	.....	Under Constr	1961	.....	.....	.....
Richfield Oil	Everett, Wash.	Refinery	.....	$50,000,000	Planning	1965	.....	.....	.....
	Watson, Calif.	*Depropanizer	.....	.....	Under Constr	1962	.....	Parsons	Parsons
Shell Oil	Martinez, Cal.	Lube Hydrotreater	.....	.....	Under Constr	Mid 1961	Shell	Braun	Braun
Standard Oil (Calif.)	Richmond, Cal.	Exp. Polybutene	.....	$3,400,000	Under Constr	1961	.....	Staff	.....
		Paraxylene	.....	.....	Engineering	1961	.....	.....	.....
		Orthoxylene	.....	.....	Engineering	1961	.....	.....	.....
	Honolulu	Refinery	32,000 bbls	$65,000,000	Under Constr	1962	.....	Staff/Bechtel	Bechtel/Hawiian Dredging
Texaco	Los Angeles	Hydrotreater	.....	.....	Complete	.....	.....	Foster Wheeler	Foster Wheeler
		CO Boiler	250,000 lbs/yr	.....	Under Constr	1961	.....	Babcock & Wilcox	C C Moore
Tidewater Oil	Avon, Cal.	Isocracking	20,000 bbls	$20,000,000	Engineering	Mid 1962	Cal Research	Cal Research	.....
Union Oil	Wilmington, Cal.	Cutter Stock Unifiner	.....	.....	Under Constr	Mid 1961	Union	Braun	Braun
United Carbon	Mojave, Calif.	Carbon Black	175,000 lbs	$5,000,000	Planning	Early 1962	.....	.....	Lummus
Wilshire	Norwalk, Cal.	Refinery Revamp	.....	.....	Under Constr	1961	.....	Braun	Staff

*First appearance in tabulation.

HPI CONSTRUCTION BOXSCORE—*Continued*

COMPANY	Plant Site	Project	Daily Capacity	Estimated Cost	Status	Probable Completion	Licensor	Engineering	Contractor
Witfield Oil	Watson, Cal.	Detergent Alkylate	.....	.....	Engineering	Late 1961	Standard-Indiana	Braun	Braun

Canada

COMPANY	Plant Site	Project	Daily Capacity	Estimated Cost	Status	Probable Completion	Licensor	Engineering	Contractor
British American Oil	Clarkson, Ont.	CO Boiler	165,000 lbs/hr	$900,000	Under Constr	Summer 1961	.....	Combustion Engineering/ Staff	Combustion Engineering/ Staff
	Montreal	Udex Aromatics Extraction, Benzene	6,000,000 gals/yr	$2,800,000	Complete	.....	UOP	UOP/Foster Wheeler/Staff	Foster Wheeler
British American Oil, et al	Calgary	Hydrodesulfuriser	3,500 bbls	$450,000	Complete	.....	.....	.....	.....
Brockville Chemicals	Maitland, Ont.	*Hydrogen	15 MMcf	.....	Under Constr	1961	Texaco/ Power-Gas/ Benfield	Power-Gas	Power-Gas
Canadian Chemicals	Edmonton, Alta.	Revamp Petrochemicals	.....	$4,000,000	Complete	.....	.....	Staff/B & R	B & R
		Exp. Refinery	.....	$4,000,000	Planning	.....	.....	.....	.....
		Exp. Acetic Anhydride, Exp. Pentaerythritol	.....	$450,000	Complete	.....	.....	Staff	Staff/B & R
Canadian Oil	Carmana, Ont.	Hydeal	350 bbls	$750,000	Complete	.....	UOP	Procon	Procon
Carstairs Operators' Committee	Carstairs, Alta.	*Gas Processing	200 MMcf	$3,000,000	Under Constr	Fall 1961	.....	Fluor	Fluor
Cities Service Ref.	Trafalgar, Ont.	Distillate Desulfurization	4,000 bbls	$500,000	Complete	.....	.....	Procon	Procon/Staff
Colombian Carbon (Canada)	Hamilton, Ont.	Carbon Black	40,000,000 lbs/yr	.....	Under Constr	Aug 1961	Staff	B & R	.....
Consumers Cooperative Refineries	Regina, Sask.	Naptha Unifiner	3,000 bbls	$3,000,000	Complete	.....	UOP	UOP/Staff	Procon Canada
		Platformer	3,000 bbls		Complete	.....	UOP	UOP/Staff	Procon Canada
		Distillate Unifiner	6,000 bbls		Complete	.....	UOP	UOP/Staff	Procon Canada
		*Exp. Crude	to 22,500 bbls	$400,000	Under Constr	Nov 1961	.....	UOP/Staff	Treco
		*Exp. Cat Cracking	to 9,000 bbls	$300,000	Under Constr	Nov 1961	UOP	UOP/Staff	.....
Dominion Rubber	Edmonton, Alta.	Petrochemicals	.....	.....	Engineering	1961	Staff	B & R	B & R
Dominion Tar & Chemical	Toronto, Ont.	Phthalic Anhydride	22,000,000 lbs/yr	.....	Engineering	Early 1962	Sherwin-Williams	Canadian Badger	Canadian Badger
Dow-Canada	Ft. Saskatchewan	Pentachlorophenol	.....	.....	Under Constr	1961	Staff	B & R	B & R
		Glycols, Ethanolamines	.....	.....	Under Constr	Summer 1961	.....	.....	.....
	Ladner, B. C.	Phenol	.....	.....	Under Constr	Mid 1961	.....	.....	.....
Golden Eagle Refining	St. Johns, Nfld.	Refinery: Crude Topping Visbreaking Platforming Unifining	7,500 bbls	$5,000,000	Under Constr	July 1961	UOP	Sweco	Lundrigan
Innisfail Operators Committee	Innisfail Field, Alta.	Sulfur Recovery	80 tons	.....	Planning	.....	.....	.....	.....
		Gas Treating	8.7 MMcf	.....	Planning	.....	.....	.....	.....
Irving Refining	Saint John, New Brunswick	Hydrogen	.....	.....	Complete	.....	.....	Girdler/ Bechtel	Canadian Bechtel
		Gas Treating, Sulfur Recovery	150 MMcf	$1,300,000	Engineering	Dec 1961	.....	Parsons	Parsons
Jefferson Lake Petrochemicals	Calgary, Alta.	Sulfur Recovery	875 tons	.....	Under Constr	Dec 1961	.....	.....	Parsons
Nottingham Gas, Carnduff Gas	Coleman, Alta.	Sulfur Recovery	380 tons	$1,250,000	Under Constr	Dec 1961	Parsons	Parsons	Parsons
	Saskatchewan	Gas Processing, Treating, Gathering	8.5 MMcf	.....	Complete	.....	.....	Tellepsen	Tellepsen
Pan American Petroleum, Canadian Fina	Whitecourt, Alta.	Gas Injection	175 MMcf	.....	Engineering	Late 1961	.....	B & R	B & R
		Gas Sweetening							
		LPG Recovery							
		Sulfur Recovery	640 tons	.....	.....	.....	.....	.....	.....
Petrogas Processing Jefferson Lake Petrochemicals	Balzac, Alta.	*Gas Gathering, Acid Gas Testing	100 MMcf	$12,500,000	Under Constr	Dec 1961	.....	Parsons	Parsons
		*Sulfur Recovery	860 tons						
Polymer	Sarnia, Ont.	Polybutadiene	20,000 tons/yr	.....	Under Constr	1962	Karl Ziegler/ Goodrich-Gulf	.....	.....
Regent Refining	Port Credit, Ont.	Benzene	.....	$2,000,000	Under Constr	Summer 1961	UOP	UOP/Bechtel	Bechtel
		*Waste Water Disposal	.....	$450,000	Under Constr	1961	.....	Staff/Bechtel	Canadian Bechtel
Sogemines	Maitland, Ont.	Synthetic Nitrogen, Ammonium Nitrate, Nitrogen Solutions, Anhydrous Ammonia	.....	$17,000,000	Engineering	1961	Chemico	Chemico	Chemico
Union Carbide Canada	Montreal East, Quebec	Partial Oxidation Gasification:	15 MMcf	$1,800,000	Under Constr	1961	.....	Power-Gas	Power-Gas
		Exp. Ethylene Oxide, Oxide Derivatives 100%	.....	.....	Complete	.....	.....	B & R	.....
		Exp. Polyethylene	to 65,000,000 lbs/yr	.....	Complete	.....	.....	B & R	.....
Westcoast Transmission	Coleman, Alta.	Gas Processing	75 MMcf	$10,000,000	Under Constr	Late 1961	.....	Canadian Bechtel	Canadian Bechte.
Western Leaseholds	near Calgary, Alta.	*Gas Gathering, Processing	80 MMcf	$6,200,000	Under Constr	Late 1961	.....	Stearns Roger	Stearns Roger

Latin America

COMPANY	Plant Site	Project	Daily Capacity	Estimated Cost	Status	Probable Completion	Licensor	Engineering	Contractor
ARGENTINA									
Argentine Government	Santa Fe	Naphtha Reforming, Aromatics Extraction	6,300 bbls	.....	Planning	.....	.....	.....	.....
	Mendoza	Topping, Delayed Coking, Catalytic Cracking	28,300 bbls	$30,000,000	Under Constr	Nov 1961	Kellogg	Kellogg	Kellogg
	Salta	Naphtha Reforming	3,150 bbls	.....	Planning	.....	.....	.....	.....
	Buenos Aires	Topping, Naphtha Reforming, Lube Oil	20,000 bbls	.....	Planning	.....	.....	.....	.....
Cabot Argentina S.A.I.C.	Buenos Aires	Carbon Black	13,000 tons/yr	$4,000,000	Under Constr	Early 1962	Cabot	Cabot	.....
Diadema Argentina Shell	Buenos Aires	Crude Still, Fluid Cat Cracker, Feed Preparation, Stabiliser	33,000 bbls	.....	Under Constr	Late 1962	.....	.....	McKee
		Cat Cracker	16,000 bbls	.....	Under Constr	1963	.....	.....	.....
Esso S.A. P.A.	Campana	Cat Cracker	8,500 bbls	.....	Under Constr	End 1961	Esso	Esso/Kellogg	Tecnastar
		Propane Dewaxing	2,000 bbls	.....	Planning	.....	Esso	Esso/Staff	.....
Hooker Chemical Atanor	Rio Tercero	Phenol	25 tons	.....	Under Constr	1962	.....	Fish	Fish

*First appearance in tabulation.

HPI CONSTRUCTION BOXSCORE—*Continued*

COMPANY	Plant Site	Project	Daily Capacity	Estimated Cost	Status	Probable Completion	Licensor	Engineering	Contractor
Hydrocarbon-Argentina	San Lorenzo	*Gasoline *Benzene	11,000 bbls 700 bbls	$13,500,000	Planning	1963	Hydrocarbon/ Atlantic	Hydrocarbon	Staff
Petroquimica Argentina	San Lorenzo	Synthetic Rubber, Cis-Polybutadiene	45,000 tons/yr	$70,000,000	Engineering	Mid 1963	.....	Fish	Fish
BRAZIL									
Industria Brasileira de Enxofre	Sao Paulo	*Sulfur Recovery	28 tons	.....	Complete	.....	.....	Graff	SETAL
North American Solvay	Sao Paulo	Ethylene Purification	20 tons	.....	Under Constr	.....	.....	Hydrocarbon	Hydrocarbon/ SETAL
Pernambuco State	Pernambuco	Synthetic Rubber	40,000 tons/yr	.....	Planning	.....	.....	.....	.....
Petroleo Brasileiro	Duque De Caxias—Rio de Janeiro	Refinery	90,000 bbls	$60,000,000	Under Constr	1961	Houdry/ UOP	Foster Wheeler	.....
	Duque De Caxias-Do Rio de Janeiro	Synthetic Rubber	40,000 tons/yr	.....	Under Constr	1962	.....	Blaw/Knox	.....
	Cubatao-Sao Paulo	Cat Reformer Aromatics Extraction Ethane Cracking	12,000 bbls 4,750 bbls 3.77 MMcf	$10,000,000	Engineering	Mid 1962	Houdry/ UOP	.....	.....
Union Carbide International	Cubatao-Santos	*Exp. Polyethylene	12,000 tons/yr	.....	Engineering	Mid 1962	Union Carbide	B & R	B & R
CHILE									
Empresa Nacional del Petroleo	Magallanes	Natural Gasoline	100 MMcf	$5,000,000	Under Constr	Jan 1962	.....	Hudson	Staff
COLOMBIA									
Amoniaco Del Caribe S.A.	Cartagena	Ammonia Nitric Acid	300 tons 150 tons	$13,000,000	Engineering	Mid 1962	.....	C & I/Girdler	C & I/Girdler
Colombian Petroleum	.....	Gasoline	40 MMcf	$450,000	Engineering	Sept 1961	.....	Pona	Staff
Gas Natural Colombiano, S.A.	Cicuco	Gas Compressor	.....	.....	Engineering	Mid 1961	.....	B & R	.....
Probst y Cia (W. R. Grace)	.....	*Formaldehyde	10 tons	.....	Complete	.....	.....	.....	.....
COSTA RICA									
Fertilizantes de Centro America (Ferticas), et al	.....	Nitrogen, Potash & Phosphorus Fertilizers, Urea	650 tons	$10,000,000	Planning	.....	.....	.....	.....
EL SALVADOR									
Esso Standard S.A.	Acajutla	*Refinery	.....	.....	Engineering	1962	.....	Parsons	Parsons
Refineria Shell de El Salvador	Acajutla	Refinery	10,000 bbls	.....	Under Constr	1962	.....	Fluor	Fluor
GUATEMALA									
Refinera Matias de Galvez	Matias de Galvez	Refinery	4,000 bbls	.....	Complete	.....	.....	Lummus	Lummus
Refineria Petrolera de Guatemala, et al	Matias de Galvez	*Refinery	12,000 bbls	.....	Planning	.....	.....	.....	.....
MEXICO									
Celanese Mexicana S.A.	Taluca	Nylon Polymer	14,000 lbs	$3,000,000	Under Constr	Dec 1961	Firestone/ Zimmer	Day & Zimmerman	Day & Zimmerman
Fertilizantes del Bajio S. A.	Salamanca	Urea	.....	.....	Planning	.....	.....	Lummus	Lummus
Negromex, S. A.	Salamanca	Carbon Black	33,000,000 lbs/yr	$4,000,000	Engineering	1962	Phillips	Pona	.....
Pemex	Minatitlan	Anhydrous Ammonia	200 tons	$8,000,000	Under Constr	Mid 1961	.....	Fluor	Fluor
		Crude	50,000 bbls		Engineering	Mid 1961	UOP	Fluor	Fluor
		Cat Reformer	.....	$23,000,000	Under Constr	Mid 1961	UOP	Fluor	Fluor
		Udex	16,000 bbls		.....	.....	.....	.....	.....
		BTX	4,800 bbls		.....	.....	UOP	.....	.....
		Hydrar	500 bbls						
		Alkar	200 bbls	$5,000,000	Engineering	Late 1961	UOP	Fluor	Fluor
		Hydeal	2,000 bbls						
	Salamanca	Anhydrous Ammonia	200 tons	$8,000,000	Under Constr	Late 1961	.....	Lummus	Lummus
		Topping	40,000 bbls						
		Cat Cracker	25,000 bbls	$13,000,000	Under Constr	Late 1961	.....	Lummus	Lummus
		Grease	25 tons	$2,100,000	Under Constr	Mid 1961	.....	McKee	McKee
	Coatzacoal COS	Ethylene	100,000,000 lbs/yr						
		Ethylene Dichloride	.....						
		Ethyl Chloride	.....	$10,000,000	Engineering	Late 1962	.....	Lummus	Lummus
		Ethylene Dibromide	.....						
		TEL	24,000,000 lbs/yr		.....	.....	.....	H & G	H & G
		*Vinyl Chloride	10,000 tons/yr	$3,000,000	Engineering	Mid 1963	.....	.....	Lummus
	Ciudad Madero	Recovery Ethylene	1,000 bbls						
		Butadiene	1,000 bbls	$15,400,000	Under Constr	.....	.....	.....	.....
		Styrene	325 bbls			.....	.....	McKee	McKee
		Dodecyl Benzene	45 tons			.....	Phillips	.....	.....
		SBR Rubber	20,000 tons/yr	$8,300,000	Under Constr	Late 1961	Polymer	McKee	McKee
	Poza Rica	Topping	15,000 bbls	$5,000,000	Under Constr	Mid 1961	.....	McKee	McKee
	Atscaposalco	Polyethylene	25,000,000 lbs/yr	$8,000,000	Under Constr	Late 1961	ICI	Simon Carver/ McKee	Simon Carver/ McKee
	La Venta	Absorption	150 MMcf	$7,500,000	Under Constr	Late 1961	.....	Hudson	Hudson
	Ciudad Pemex	Exp. Absorption	to 500 MMcf						
	Reynosa	Exp. Absorption	to 500 MMcf	$3,500,000	Under Constr	Late 1961	.....	Hudson	Hudson
NICARAGUA									
Esso Standard S.A.	.....	*Refinery	.....	.....	Engineering	1962	.....	Parsons	Parsons
PANAMA									
Panama Refining & Petrochemical	Portobelo	Refinery	55,000 bbls	$50,000,000	Engineering	Oct 1962	.....	McKee	.....
		Aromatics	13,000 bbls		Under Constr	April 1962	UOP	McKee	.....
Refineria Panama, SA	Las Minas Bay Colon	Refinery; Petrochemicals	55,000 bbls	$45,000,000	Under Constr	Dec 1961	.....	Bechtel	Bechtel
TRINIDAD									
Shell Trinidad	Point Fortin	Distillation Revamp	14,000 bbls	.....	Under Constr	Mid 1961	.....	.....	.....
Texaco Trinidad	Pointe-a-Pierre	Crude Topping	100,000 bbls	.....	Complete	.....	.....	Fluor	Caribbean Bechtel
		Cat Reformer	15,000 bbls	.....	Complete	.....	.....	Fluor	Caribbean Bechtel
		Hydrotreater	20,000 bbls	.....	Complete	.....	.....	Staff	Caribbean Bechtel
URUGUAY									
Administracion Nacional de Combustibles Alcohol Y Portland	Montevideo	Vacuum Distillation	10,000 bbls						
		Cat Cracker	5,000 bbls				.....		
		Cat Reformer	3,000 bbls	$10,500,000	Complete	.....	.....	Kellogg/Staff	Staff
		Gas Concent. & Bottling	.....				.....		
		Gas Sweetening	4,500 bbls				.....		
		Sulfur Recovery	6 tons				.....		
		Power & Offsite Facilities	3,600 kw	$1,500,000	Complete	.....	.....		
		CO Boiler	.....				.....	.....	.....
VENEZUELA									
Mene Grande Oil	Eastern Venezuela	Compressor Stations	.....	.....	Engineering	.....	.....	B & R	.....

* First appearance in tabulation.

HPI CONSTRUCTION BOXSCORE—*Continued*

COMPANY	Plant Site	Project	Daily Capacity	Estimated Cost	Status	Probable Completion	Licensor	Engineering	Contractor
United Carbon Venezuela	Valencia	Carbon Black	20,000,000 lbs/yr	$4,000,000	Planning	Early 1962	.....	Lummus	Lummus
Venezuela-Gulf Refining	Puerto la Cruz	HF Alkylation	2,200 bbls	.....	Under Constr	Late 1961	.....	Foster Wheeler	Foster Wheeler

Europe

COMPANY	Plant Site	Project	Daily Capacity	Estimated Cost	Status	Probable Completion	Licensor	Engineering	Contractor
AUSTRIA									
Power-Gas	Graz	Catalytic Oil Gasification	1.75 MMcf	.....	Complete	.....	Power-Gas	Didier	Didier
Oesterreich Mineral-oelver-Waltung	Schwechat, near Vienna	Gas Recovery	14 MMcf	.....	Complete	.....	.....	Lurgi	Lurgi
		Cat Cracker	10,000 bbls	.....	Under Constr	1962	UOP	Comprimo	Voest
		Feed Preparation	30,000 bbls	.....	Engineering	1962	.....	UOP	.....
Vienna Gasworks	Vienna	Cat Reformer	18.2 MMcf	.....	Engineering	1951	.....	Otto	Otto
BELGIUM									
Albatros	Antwerp	Exp. Refinery	.....	$2,000,000	Under Constr	1961	.....	Badger N V	Badger N V
Amoco Fina	Antwerp	Petroleum Additives	.....	.....	Complete	.....	.....	.....	.....
Cobenam, S.A.	Antwerp	Ethylene	.....	.....	Engineering	1961	S & W	S & W	.....
		Polyethylene	.....	.....	Under Constr	Late 1961	Union Carbide	George Wimpey/ B & R/Staff	B & R/Others
Raffinerie Belge de Petroles	Antwerp	LPG & Sulfur Recovery	.....	$1,900,000	Under Constr	1961	.....	Technip	Oxy France/ Technip
Societe Chimique de Selzaete	Zelzaete	Maleic Anhydride	.....	.....	Under Constr	Spring 1962	SD	SD/SFST	SFST
Societe Industrielle	Antwerp	Crude Distillation	100,000 bbls	.....	Under Constr	Late 1962	.....	Foster Wheeler	Foster Wheeler
		Catalytic Reformer	9,000 bbls	.....	Under Constr	Late 1962	.....	Foster Wheeler	Foster Wheeler
		Hydrofiner	10,000 bbls	.....	Under Constr	Late 1962	.....	Foster Wheeler	Foster Wheeler
		Sulfur Recovery	60 tons	.....	Under Constr	Late 1962	.....	Foster Wheeler	Foster Wheeler
Belge des Petroles	Ghent	Phthalic Anhydride	5,000 tons/yr	$2,000,000	Under Constr	1961	Sherwin-Williams	Badger NV	Badger NV
Union Chemique Belge									
BULGARIA									
Technoimport	Dewnja	*Acetylene	35 tons	.....	Engineering	1962	Knapsack-Grie-sheim	Uhde	Chemiebau Zieren
DENMARK									
Dansk Veedol	Kalundborg	Refinery	20,000 bbls	.....	Under Constr	1961	.....	Foster Wheeler	Foster Wheeler
Imperial Chemical Industries	Copenhagen	Polyethylene	.....	$11,200,000	.....	.....	ICI	.....	.....
Maersk	Copenhagen	Ethylene	.....	.....	.....	.....	.....	S & W	.....
ENGLAND									
British Chrome & Chemicals	Urlay Nook	Sulfuric Acid	100 tons	.....	Complete	.....	Chem-iebau	Power-Gas	Power-Gas
British Petroleum	Kent	*Fractionation, Platformer (Aromatics)	236,000,000 lbs/yr	.....	Under Constr	1962	.....	Badger Mfg	Badger Mfg
		*Paraxylene	1,400 tons/yr	.....	Under Constr	April 1962	.....	Bechtel	Wimpey
British Petroleum/ California Chemical	Kent	Orthoxylene Ethylbenzene Paraxylene	19,000 tons/yr 16,000 tons/yr 22,000 tons/yr	$19,600,000	Under Constr	1962	Cal Research	Stafff/Badger	Bechtel/Badger
East Midlands Gas Board	Grimesthorpe	Catalytic Oil Gasification	10 MMcf	.....	Engineering	Oct 1962	Onia Gegi	H & G	H & G
	Dinnington	Catalytic Oil Gasification	3.5 MMcf	.....	Under Constr	Late 1961	Onia Gegi	H & G	H & G
Esso Petroleum	Fawley	Exp. Petrochemicals	.....	.....	Engineering	1961	Esso	Foster Wheeler	Foster Wheeler
		Butyl Rubber	30,000 tons/yr	$14,000,000	.....	.....	.....	Foster Wheeler	Foster Wheeler
Grange Chemical	Hull	*Phthalic Anhydride	16,537 tons/yr	.....	Under Constr	1962	Cal Research	Badger Mfg	Badger Mfg
Imperial Chemical Industries	Wilton	Ammonium Nitrate Granulation	.....	.....	.....	.....	SBA	.....	.....
	Severnside	*Ethylene Oxide	66,000,000 lbs/yr	.....	Under Constr	Winter 1961	SD	SD	.....
Mobil International	Coryton	Exp. Crude	to 46,500 bbls	$2,000,000	Engineering	1962	.....	.....	.....
Monsanto	Newport	Maleic Anhydride	15,000,000 lbs/yr	.....	Under Constr	.....	SD	SD	SD
Northern Gas Board	Darlington	Catalytic Oil Gasification	2 MMcf	.....	Complete	.....	.....	Power-Gas	Power-Gas
North Eastern Gas Board	Whitby	Natural Gas Reforming	1.25 MMcf	.....	Complete	.....	Hercules	Power-Gas	Power-Gas
		Refinery	75,000 bbls	.....	Planning	.....	.....	.....	.....
North Western Gas Board	Ellesmere Port	Gas Reforming	15 MMcf	.....	Under Constr	Late 1961	Onia Gegi	H & G	H & G
	Partington	Gas Reforming	12 MMcf	.....	Under Constr	Late 1961	Onia Gegi	H & G	H & G
Shell Chemical	Carrington	Ethylene	.....	.....	Planning	.....	.....	Lummus	Lummus
Shell Refining	Stanlow	*Platformer	6,700 bbls	.....	Planning	1963	.....	.....	.....
	Shell Haven	*Isopentane	3,800 bbls	.....	Planning	1963	.....	.....	.....
South Eastern Gas	Isle of Grain	Hydrogen	18 MMcf	.....	Under Constr	.....	.....	Woodall-Duckham	Woodall-Duckham
Union Carbide	Fawley	Ethylene Oxide & Derivatives	.....	.....	Under Constr	.....	.....	.....	.....
West Midlands Gas Board	Birmingham	Cat Reformer	5 MMcf	.....	Engineering	1962	Otto	Simon-Carves	Simon-Carves
	Stoke on Trent	*Light Distillate Gasification	8 MMcf	.....	Engineering	1962	Onia Gegi	H & G	H & G
Woodall Duckham	Fulham	Producer Gas	15 MMcf	.....	Under Constr	Oct 1961	H & G	H & G	H & G
EIRE									
Alliance & Dublin Consumers Gas	Dublin	*Catalytic Oil Gasification	.....	.....	Engineering	1962	.....	Power-Gas	Power-Gas
FINLAND									
Neste Oy	Naantali	Exp. Refinery: Desalting, Crude Distillation	24,000 bbls	.....	Under Constr	1962	Howe-Baker	Lummus	.....
		Cat Reformer	3,000 bbls	.....	Under Constr	1962	Sinclair	Lummus	.....
		Hydrodesulfurization	6,000 bbls	.....	Under Constr	1962	Shell	Lummus	.....
Typpi Oy	Oulu	Exp. Ammonia, Nitric Acid	60 tons	.....	Engineering	Late 1962	Linde/ Pintsch-Bamag/ Uhde	Linde/Pintsch-Bamag/Uhde/ Staff	Linde/Pintsch-Bamag
FRANCE									
Ammonia	Vendin-La-Vieille	Ammonium Nitrate	.....	.....	.....	.....	SBA	SBA	SBA
Antar-Petroles del' Atlantique	Donges	Crude Topping	75,000 bbls	.....	Under Constr	July 1961	.....	Technip	Technip
		Gasoline & Aromatics Super-fractionation	163,000 gals	.....	Under Constr	March 1962	.....	Technip	.....
Compagnie DE Raffinage Shell-Berre	Strasbourg	*Refinery	72,000 bbls	.....	Engineering	Dec 1962	.....	Bechtel/SPIE Serete	Bechtel/SPIE Serete
Compagnie Francaise des Matieres Colorantes	Villers-St.-Paul	Phthalic Anhydride	.....	.....	Under Constr	Late 1961	SD	SD/SFST	SFST

***First appearance in tabulation.**

HPI CONSTRUCTION BOXSCORE—*Continued*

COMPANY	Plant Site	Project	Daily Capacity	Estimated Cost	Status	Probable Completion	Licensor	Engineering	Contractor
Compagnie Francaise des Petroles/ CompagnieFrancaise de Raffinage	Strasbourg	Refinery	70,000 bbls	.....	Planning	.....	.....	.....	.....
		Platforming	21,200 bbls	.....	Engineering	March 1963	UOP	Technip	Staff
	Gonfreville l'Orcher	Cat Reforming	15,000 bbls	.....	Planning	1963	.....	.....	.....
		Ethylene, Steam Cracking	50,000 tons/yr	.....	Planning	1963	.....	.....	.....
Compagnie Rhenane de Raffinage	Strasbourg	*Refinery	70,000 bbls	.....	Engineering	Mid 1963	.....	.....	.....
Esso Francaise	Port Jerome	Aromatics Extraction	.....	.....	Under Constr	Early 1962	.....	Foster Wheeler	Foster Wheeler
Ethyl Synthese	Lillebonne	Monomer Styrene	25 to 30,000 tons/yr	.....	.....	.....	Koppers	SBA	.....
Esso Standard	Port Jerome	Lube Hydrofiner	4,000 bbls.	.....	Under Constr	1961	Esso	Esso Lummus	Lummus
		Paraxylene, Orthoxylene, Solvents	52,000 tons/yr	.....	Under Constr	1962	Esso	Esso	Foster Wheeler
		Propylene	29,000 tons/yr	.....	Engineering	1962	Esso	Esso	.....
Firestone France S.A.	Port Jerome	Copolymer	.....	.....	Under Constr	1961	.....	Lummus	Lummus
Houilleres du Bassin de Lorraine	Carling	Nitric Acid	.....	.....	Engineering	.....	SBA	SBA	SBA
Mekog	Pernis	Ammonium Nitrate Neutralization & Concentration	.....	.....	.....	.....	SBA	SBA	Staff
Mobil Oil	Gravenchon	Exp. Lube	to 3,500 bbls	$5,200,000	Under Constr	Mid 1962	.....	Foster Wheeler	Mobil Oil Francaise
Naphthachimie	Lavera	Exp. Butadiene Recovery	8,000 tons/yr	.....	Planning	.....	.....	Foster Wheeler	Foster Wheeler
		Polyisobutene	.....	.....	Engineering	Summer 1961	Coden	Badger France	Badger France
		Propylene	.....	$1,000,000	Under Constr	1961	.....	Badger NV/ Badger France	Badger France
Pierrefitte, Ste. Generale d'Engrais & Produits Chimiques	Pierrefitte-Nestalas	Ammonium Nitrate Treating	600 tons	.....	Under Constr	1961	Pierrefitte	Solemca	Staff
Polymer S.a.r.L.	Strasbourg	Specialty Rubber	.....	$10,000,000	Engineering	1962	Polymer	Badger NV/ Badger SarL	Badger NV/ Badger SarL
Progil Electrochemie	Pont de Claix	*Bispheno!	.....	.....	Under Constr	.....	.....	.....	Lummus
Proisvodnja	Lendava	Synthesis Gas	.....	.....	.....	.....	SBA	SBA/TOPSOE	RAMA
Reichhold-Beckacite	Niort	Maleic Anhydride	.....	.....	Under Constr	Spring 1962	.....	SD/SFST	SFST
Rhone-Poulene	Lavera	Acetaldehyde	.....	.....	Planning	.....	Hoechst	Uhde	Uhde
Societe des Produits d'Aquitaine	Chimique Lacq	Synthetic Ammonia	200 tons	$6,000,000	Engineering	1961	.....	Chemico/ Solemca	Chemico/ Solemca
		Acetylene from Nat. Gas	75 tons	.....	Under Constr	.....	BASF	BASF/Heurtey	Heurtey
Societe Francaise des Petroles/BP	Dunkerque	Lube Hydrofinisher	3,100 bbls	.....	Under Constr	Mid 1961	Staff/BP	Staff/BP	.....
		Bitumen	100,000 tons/yr	.....	Engineering	1961	.....	Techrip/ Lummus	Techrip/ Lummus
		*Topping	2,000 tons	.....	Under Constr	1961	Staff/BP	Staff/BP	.....
Soc. Nationale des Petroles D'Aquitaine	Lacq	Desulfurization	175 MMcf	.....	Under Constr	1961	.....	Technip	Staff
		Sulfur Recovery	1,100 tons	.....	Under Constr	1961		Parsons & Heurtey	Staff
		Natural Gasoline	120 MMcf	.....	Under Constr	1961	.....	Lummus	Staff
		DEA Washing	140 MMcf	$1,000,000	Under Constr	1961	.....	Technip	Staff
		Preliminary Desulfurization	350 MMcf	.....	Under Constr	1961	.....	Technip	Staff
		Platforming	2,700 bbls	.....	Engineering	July 1962	UOP	Technip	Staff
		Hydrogen	5,300 Mcf	.....	Engineering	July 1962	TOPSOE	Technip	Staff
		*Benzene	.....	.....	Under Constr	1962	UOP	Parsons/ Heurtey	Staff
		*Cyclohexane	30,000 tons/yr	.....	Engineering	1962	.....	Technip	Staff
		Hydrodesulfurization	2,900 bbls	.....	Engineering	1962	.....	Foster Wheeler	Staff
Societe Nationale des Petroles d'Aquitaine El Paso Natural Gas Societe Nationale REPAL	Lacq	*Isoprene	1 ton	.....	Engineering	.....	Institute Francais du Petrole	Technip	Technip
Soc. Pechiney	St. Auban	*Carbide Furnace	.....	.....	Under Constr	1962	Knapsack-Griesheim	Uhde	Ubde
Soc. Vinylacq	Lacq	Vinyl Chloride	.....	.....	Planning	.....	.....	.....	.....
United Carbon	Port Jerome	Carbon Black	25,000 tons/yr	.....	Under Constr	1961	United Carbon	Solemca	Compagnie Francaise
	Rouen	Carbon Black	50,000,000 lbs/yr	$5,000,000	Planning	1961	.....	.....	.....
EAST GERMANY									
DIA Chemie Ausruestung Berlin	Leuna	Ethylene Aromatics	40,000 tons/yr	$12,000,000	Under Constr	1962	Petrocarbon	Petrocarbon/ H & G	Staff/H & G
Leuna-Werk Walter Ulbricht	.....	Urea	.....	.....	Planning	.....	.....	.....	.....
		Ammonium Nitrate	.....	.....	Planning	.....	.....	.....	.....
		Exp. Nitrogen	to 400,000 tons/yr	.....	Planning	1965	.....	.....	.....
Ministry of Coal & Energy	Stralsund	Catalytic Oil Gasification	4.8 MMcf	.....	Complete	.....	Power-Gas	Power-Gas/ Didier	Didier
Pierstertitz Nitrogen	.....	Exp. Nitrogen	to 20,000 tons/yr	.....	Planning	1961	.....	.....	.....
WEST GERMANY									
Badische Anilin & Sod. Fab.	Ludwig-Shafen	Phthalic Anhydride	35,000,000 lbs/yr	.....	.....	.....	.....	Foster Wheeler	Foster Wheeler
B.P. Benzin und Petroleum	Dinslaken	Cat Cracker	10,000 bbls	.....	Under Constr	1961	.....	Kellogg	Kellogg
		Copper Chloride	4,000 bbls	.....	Under Constr	1961	.....	Kellogg	Kellogg
		Bitumen	100,000 tons/yr	.....	Under Constr	1961	.....	Kellogg	Kellogg
British Petroleum	Dinslaken	*Fractionation, Platformer (Aromatics)	90,000,000 lbs/yr	.....	Under Constr	1962	.....	Badger Mfg	Badger Mfg
British Petroleum California Chemical	Dinslaken	Paraxylene	14,000 tons	.....	Engineering	Mid 1962	Cal Research	Staff	Lurgi
Chemische Fabrik Holten	Luhwigshaven/ Rhein	Ethylene Oxide	9,000,000 lbs/yr	.....	Under Constr	.....	S D	S D	.....
Chemische Werke Huls	Marl	Polyethylene	6,000 tons/yr	.....	Complete	.....	Ziegler	Staff	Staff
		Polybutadiene	20,000 tons/yr	.....	Planning	1963	.....	Staff	.....
		Exp. Polyvinylchloride	to 80,000 tons/yr	.....	Under Constr	1961	.....	Staff	.....
		Exp. Polystyrene	to 30,000 tons/yr	.....	Under Constr	1961	.....	Staff	.....
		Polypropylene	3,000 tons/yr	.....	Under Constr	End 1961	Ziegler	Staff	.....
Deutsche Erdoel	Heide	Exp. Refinery	50,000 bbls	.....	Engineering	1962	.....	Edeleanu/Staff	.....
		Urea Dewaxing	700 bbls	.....	Under Constr	1961	Edeleanu	Edeleanu	Edeleanu
		Isobutylene Extraction	770 bbls	.....	Under Constr	1961	Esso	Edeleanu	Edeleanu
Deurag-Nerag	Hannover	Crude Distillation, Thermal Cracker	21,000 bbls	.....	Complete	.....	.....	Lummus	Lummus
Deutsche Shell	Godorf	Exp. Platformer, Hydrodesulfurisation	40,000 bbls	.....	Planning	1961	.....	.....	.....
		*Further Debottlenecking	15,000 bbls	.....	Complete	.....	.....	.....	.....
Eblingen Gasworks	Eblingen	Cat Reformer	2.6 MMcf	.....	Under Constr	1961	Otto	Otto	Otto
		Gas Conversion	2.6 MMcf	.....	Under Constr	1961	Otto	Otto	Otto
Einbeck Gasworks	Einbeck	Cat Reformer	500 Mcf	.....	Engineering	1961	Otto	Otto	Otto
Elmshorn Gasworks	Elmshorn	Cat Reformer	750 Mcf	.....	Engineering	1961	Otto	Otto	Otto
Erdolchemie	Dormagen/ Niederrhein	Propylene Oxide	20,000 tons/yr	.....	Complete	.....	Farbenfabriken/ Bayer	Farbenfabriken/ Bayer	Farbenfabriken/ Bayer

***First appearance in tabulation.**

HPI CONSTRUCTION BOXSCORE—*Continued*

COMPANY	Plant Site	Project	Daily Capacity	Estimated Cost	Status	Probable Completion	Licensor	Engineering	Contractor
Erdolchemie (Cont.)		Butadiene	30,000 tons/yr	.....	Complete	.....	Esso	Lurgi	Lurgi
		Gasoline Selective Hydrogenation	120,000 tons/yr	.....	Complete	.....	BP	BP/Lurgi	Lurgi
		Di-isobutylene, Tri-isobutylene	45,000 tons/yr	.....	Under Constr	1961	Farbenfabriken	Lurgi	Lurgi
Esso A.G.	Cologne	Steam Cracker, Ethylene Recovery, Petrochemicals	5,000 bbls	$11,000,000	Under Constr	1961	Esso	Lurgi	.....
	Karlsruhe	Refinery	68,000 bbls	$35,000,000	Engineering	Late 1962	Esso/UOP	Lurgi/Lummus/Uhde	Lurgi/Lummus Uhde
Ewald-Kohle	Recklinghausen	Maleic Anhydride	.....	.....	Under Constr	Late 1961	SD	SD/SFST	.....
Farbwerke Hoechst A. G.	Frankfurt-Hoechst	Propane-Propylene Splitter	1,500 tons/month	.....	Under Constr	Mid 1961	.....	Uhde	Uhde
Feldmuhle A.G.	Lulsdorf	*Acetylene	32 tons	.....	Engineering	1961	Knapsack Grieshelm	Unde	Unde
Gelsenberg Benzin AG	Gelsenkirchen	Platformer	12,500 bbls	$5,300,000	Under Constr	1961	UOP	Lurgi	Lurgi
		*Benzene Extraction	700 bbls	$3,000,000	Under Constr	1961	UOP	Lurgi	Lurgi
Gewerkschaft Erdol-Raffinerie Emsland	Lingen Holthausen	Gas Oil Desulfuriser	5,500 bbls	.....	Planning	.....	UOP/Shell	Lummus	Lummus
		Crude Distillation and Coking	10 000 bb.s	.....	Planning	.....	.....	Lummus	.....
Gewerkschaft Victor Chemische Werke	Castrop-Rauxel	Synthesis Gas	22 MMcf	.....	Under Constr	Late 1961	Shell/Lurgi	Lurgi	Lurgi
		*Nitric Acid	45 tons	.....	Complete	.....	Uhde	Uhde	Uhde
Heilbronn Gasworks	Heilbronn	Cat Reformer	5.5 MMcf	.....	Engineering	1961	Otto	Otto	Otto
Kali Chemie	Bad Henningen	Hydrogen	.....	.....	.....	.....	Hercules	Power-Gas	Power-Gas
Oelwerke Julius Schindler	Hamburg-Neuhof	Solvent Dewaxing	2,500 bbls	$4,000,000	Under Constr	1961	Edeleanu	Edeleanu	Edeleanu
		*Refinery Modernization	.....	.....	Engineering	1962	.....	Uhde	Uhde
Purifina Mineraloraffinerie A.G.	Diusberg	*Unifiner, Crude Distillation Revamp	.....	.....	Planning	.....	.....	.....	Lummus
Rheinische Olefinwerke	Wesseling Bes.	Ethylene	75,000 tons	.....	Complete	.....	.....	Braum/Lurgi	Staff
Rheinpreussen A. G.	Meerbeck	Maleic Anhydride	.....	.....	Engineering	Spring 1962	SD	SD/SFST	.....
Ruhrchemie	Oberhausen-Holten	Polyethylene	.....	.....	Under Constr	.....	Staff	Uhde	Staff/Uhde
		*Desalter	1,450 tons	.....	Complete	.....	Howe-Baker	Uhde	Uhde
Scholven Chemie A. G.	Gelsenkirchen-Buer	Ethylene	.....	.....	Planning	.....	.....	Lummus	Lummus
Union Rheinische Braunkohlen	Wesseling	Synthesis Gas	10 MMcf	.....	Under Constr	1961	Shell/Lurgi	Lurgi	Lurgi
Kraftstoff A. G.	.....	Synthesis Gas	10 MMcf	.....	Under Constr	Early 1962	Shell/Lurgi	Lurgi	Lurgi
Westdeutsche Erdolleitungs-Gesellschaft	Ruhlermoor	*Crude Distillation	.....	.....	Under Constr	1961	.....	Uhde	Uhde
		*Crude Desalter	5,700 bbls	.....	Engineering	.....	Howe-Baker	Uhde	Uhde
Wintershall A.G.	Dueste	*Gas Purification	28 MMcf	$2,000,000	Engineering	Fall 1962	Fluor	Fluor	Fluor
GREECE									
Dow Chemical	Lavrion	Polystyrene Plastic	.....	$1,000,000	Under Constr	1961	.....	Foster Wheeler	Foster Wheeler
Greek Government	Ptolemaeus	Ammonia	300 tons	.....	Under Constr	Mid 1963	Uhde, Casale	Uhde, Casale	Uhde, Casale
		Ammonium Sulfate	525 tons						
		Ammonium Nitrate	325 tons						
Hellenic Petroleum Refinery	Aspropygas	LPG	25,000 tons/yr	.....	Under Constr	Mid 1961	.....	Hydrocarbon	Staff
HUNGARY									
Komplex	Borento	PVC Suspension	.....	.....	Planning	.....	Hoechst	Uhde	Uhde
ITALY									
Alchemy	Belvedere	*Maleic Anhydride	.....	.....	Under Constr	1961	.....	Petrocarbon	Staff/Petrocarbon
Asfalti BitumiCementic Derivati, S.A.	Ragusa	Exp. Polyethylene	to 80 tons	.....	Under Constr	.....	.....	.....	.....
Azienda Nazionale Idrogenazione Combustibil	Ravenna	Butadiene	22,000 tons/yr	.....	Engineering	.....	Houdry	Catalytic	.....
		Ethylene	.....	.....	Under Constr	.....	Koppers	ANIC	.....
	Gela, Sicily	Refinery	.....	.....	Under Constr	1962	.....	.....	.....
		Ethylene	.....	.....	.....	.....	.....	S & W	.....
Bombrini Parodi-Delfino	Colleferro	*Maleic Anhydride	10,000,000 lbs/yr	.....	Engineering	Mid 1962	SD	SD	.....
Condor Societa per L'Industria Petrolifera e Chemica	Rho	Crude Distillation	6,000 bbls	.....	Under Constr	Mid 1961	.....	.....	.....
Dow Chemical Italiana	Livorno	Polystyrene	.....	.....	Under Constr	1962	.....	Foster Wheeler	Foster Wheeler
Industria Raffinazione Oil Minerali	Venice	Cat Reformer	4,000 bbls	.....	Under Constr	Mid 1961	UOP	UOP/SNAM Progetti	SNAM Progetti
		Unifiner-Platformer	4,000 bbls	.....	Under Constr	1961	UOP	UOP/SNAM Progetti	SNAM Progetti
Montecatini Societe Generale per l'Industria Mineraria Chimica	Ferrara	Exp. Polypropylene	2,200,000 lbs/yr	.....	Under Constr	.....	S D	S D	.....
	Castellanza	Exp. Formaldehyde	.....	.....	Planning	.....	.....	.....	.....
	Brindisi	Petrochemical	135,000,000 lbs/yr	$300,000	Under Constr	.....	.....	.....	.....
			700,000 tons/yr	$95,000,000	Under Constr	1962	.....	.....	.....
Phillips Petroleum & ANIC	.....	Carbon Black	25,000,000 lbs/yr	.....	Planning	1962	Phillips	.....	.....
Purfina Italiana	Rome	Refinery	20,000 bbls	$10,000,000	Planning	1962	.....	.....	.....
	Genoa	Topping Revamp	13,000 bbls	$500,000	Under Constr	1961	.....	Staff	Staff
		Trickle Hydrodesulfurization	2,200 bbls	$350,000	Engineering	1961	Shell	CTIP	Staff
Sincat	Priolio, Sicily	Ethylene	2,200 bbls	$500,000	Engineering	1961	Shell	CTIP	Staff
Societe per Azonial Reffineria Olii Minerali	Ravenna	Cat Reformer	.....	.....	.....	.....	.....	Foster Wheeler	.....
Union Carbide	Sicily	Polyethylene	.....	.....	.....	.....	.....	.....	.....
Societa Edison S.A.	Celene	Ethylene Oxide	15,000 tons/yr	.....	Under Constr	.....	.....	.....	.....
	Mantua	Acetaldehyde	.....	.....	Planning	.....	Aldehyd	Uhde	Uhde
Malta Gas Board	Valetta	Catalytic Oil Gasification	26,500,000 lbs/yr	.....	Complete	.....	.....	.....	.....
			1 MMcf	.....	Complete	.....	.....	Power-Gas	Power-Gas
NETHERLANDS									
Dow Nederland N. V.	Rotterdam	Latex	.....	$2,000,000	Complete	.....	Dow	Badger N V	Badger N V
Elektro-Zuur en Waterstoffabriek	Amsterdam	*Acetylene	32 tons	.....	Engineering	1961	Knapsack-Grieshelm	Uhde	Uhde
N.V. Chemische Industries Synres Allied Chemical	.....	*Phthalic Anhydride	10,000,000 lbs/yr	.....	Engineering	1962	Sherwin-Williams	Badger NV	Badger NV
N.V. Mattschappij Tot Exploitatie Van Kooksovengossen	Ijmuiden	Gas Reforming	4.4 MMcf	.....	Under Constr	.....	.....	.....	.....
		CO Conversion	.....	.....	Planning	.....	.....	.....	.....
Shell Nederland Raffinaderij N. V.	Pernis	Platformer	6,700 bbls	.....	Under Constr	1961	.....	.....	.....
		Hydrodesulfurization	15,000 bbls		Under Constr	1961	.....	.....	.....

*First appearance in tabulation.

HPI CONSTRUCTION BOXSCORE—*Continued*

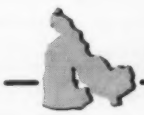
COMPANY	Plant Site	Project	Daily Capacity	Estimated Cost	Status	Probable Completion	Licensor	Engineering	Contractor
Staatsmijner in Limburg	Geleen	Phthalic Anhydride	.....	.....	Under Constr	1961	S D	SFST	.....
		Ethylene	.....	.....	.....	.....	.....	S & W	S & W
Tilburg Gasworks	Tilburg	Cat Reformer	6.8 MMcf	.....	Engineering	1961	Otto	Otto	Otto/Simon-Carves
NORTHERN IRELAND									
British Petroleum	Belfast	Refinery	30,000 bbls	$22,400,000	Planning	.....	.....	.....	.....
POLAND									
Polimex	Oswiecim	Polystyrene	35,000 bls	$1,500,000	Complete	.....	Petro-carbon	Petrocarbon	Staff
Polish Government	Plock	Refinery	40,000 bbls	.....	Planning	1965	.....	.....	.....
		Hydrogen	1.5 MMcf	.....	.....	.....	.....	.....	.....
		Fuel Gas	11 MMcf	.....	.....	.....	.....	.....	.....
PORTUGAL									
Nitratos de Portugal S.a.r.L.	Lisbon	Calnitro	305 tons	.....	Complete	.....	.....	Uhde/Werkspoor	Uhde/Werkspoor
Petroquimica S.a.r.L.	Lisbon	Ammonia	187 tons	.....	Under Constr	1961	Texaco/ Uhde	Uhde	Uhde
Sociedade Anonima Concessionaria da Refinacao de Petroleos	Lisbon	*CO Boiler	720 tons	$360,000	Engineering	Dec 1961	.....	John Thompson	John Thompson
		*Topping Revamp	5,000 tons	$350,000	Engineering	Jan 1962	.....	Litwin	Staff
		Fractionation	460 tons	$600,000	Engineering	Feb 1962	.....	Hydrocarbon	Hydrocarbon
		TCC Revamp	2,300 tons	$650,000	Engineering	Sept 1961	Socony Mobil	Hydrocarbon	Staff
Uniao Fabril do Azoto.	Lavradio, near Lisbon	*Urea	135 tons	.....	Under Constr	1962	.....	Kellogg	Kellogg
RUMANIA									
Rumanian Govt.	Teleajen	Lube Oil	.....	.....	Planning	.....	.....	.....	.....
		Natural Gas Treating	.....	.....	Planning	.....	.....	.....	.....
	Borzesti	Petrochemical	.....	.....	Planning	.....	.....	.....	.....
		*Polystyrene	.....	.....	Under Constr	.....	Petro-carbon	Petrocarbon	Petrocarbon/ Staff
	Onesti	Synthetic Rubber	.....	.....	Planning	.....	.....	.....	.....
SCOTLAND									
British Hydrocarbon Chemicals	Grangemouth	Methanol	.....	.....	Under Constr	1961	.....	Chemico	Chemico
		Butadiene	.....	.....	Complete	.....	Esso	Fluor	Fluor
		Ethylene Dichloride	.....	.....	Complete	.....	Ethyl	Lummus	Lummus
Scottish Gas Board	Fifeshire	Stage 2 Pressure Gasification	15 MMcf	.....	Under Constr	1962	Lurgi, et al	H & G	H & G
SPAIN									
Monsanto Iverica S. A.	Monsen	Acetaldehyde, Acetic Acid	.....	.....	Planning	.....	Knapsack-Griesheim	Uhde	Uhde
Repesa	Escombreras (Cartagena)	Ammonia	325,000,000 lbs	$32,000,000	Under Constr	1962	Texaco/ Giamma-rco/	Foster Wheeler Uhde	Foster Wheeler Uhde
		Ammonium Sulfate	600,000 tons						
		Urea	210,000 tons					Chemico/Dorr-Oliver	Chemico/Dorr-Oliver
		*Urea	.....	.....	Engineering	.....	DSM	Braun	Foster-Wheeler
SWEDEN									
Mo och Domsjo Aktiebolag	Stenungsund	*Ethylene Oxide	33,000,000 lbs/yr	.....	Engineering	Mid 1962	SD	SD	.....
Svenska Esso A.B.	Stenungsund	*Steam Cracking	.....	$15,000,000	Engineering	Spring 1963	.....	Fluor	Fluor
SWITZERLAND									
Miranco	Mendrisio	Lube Oils	500 bbls	$1,500,000	Under Constr	.....	.....	Staff	.....
Power-Gas	Winterthur	Catalytic Oil Gasification	606 MMcf	.....	Complete	.....	Power-Gas	Power-Gas Didier	Power-Gas Didier
U.S.S.R.									
Techmachimport	Angarsk, Siberia	Acetylene	.....	.....	Engineering	.....	SBA	SBA	SBA
		Synthetic Ammonia	.....	.....	Engineering	.....	SBA	SBA	SBA
		*Polystyrene	5,000 tons/yr	.....	Engineering	1962	BX Plastics	Power-Gas	Power-Gas
WALES									
British Hydrocarbon Chemicals	Baglan Bay, South Wales	Petroleum Chemicals	.....	.....	Planning	.....	.....	.....	.....
		*Ethylene	.....	.....	Engineering	1962	.....	S & W	S & W
		*Ethylene Dichloride	.....	.....	Engineering	1962	Ethyl	Lummus	Lummus
		*Butadiene	.....	.....	Engineering	1962	.....	S & W	S & W
Forth Chemicals	Baglan Bay, South Wales	Styrene Monomer	50,000 tons/yr	.....	Engineering	1962	Monsanto	Monsanto	.....
YUGOSLAVIA									
Komplex	Berente	*Acetylene	12 tons	.....	Engineering	1962	Hoechst	Uhde	Uhde
Yugoslav Govt.	Sisak	Topping	15,000 bbls	$10,000,000	Planning	Spring 1963	.....	.....	.....
		Delayed Coking	4,950 bbls						
		Platforming	3,020 bbls						
	Kutina	Ammonia	.....	.....	Planning	.....	.....	.....	.....
	Zagreb	Petrochemicals	.....	.....	Planning	Mid 1962	.....	Foster Wheeler	Foster Wheeler
	Rijeka	Topping	1,000,000 tons/yr	.....	Planning	.....	.....	.....	.....
		Naphtha Rerunning	140,000 tons/yr						
		Platforming	100,000 tons/yr						
		Sulfur Recovery	5,000 tons/yr						
	Bosanski Brod	Topping	640,000 tons/yr	.....	Planning	.....	.....	.....	.....

COMPANY	Plant Site	Project	Daily Capacity	Estimated Cost	Status	Probable Completion	Licensor	Engineering	Contractor
ALGERIA									
Societe de La Raffinerie D'Alger	Algiers	Refinery	55,000 bbls	$40,000,000	Under Constr	July 1963	.....	.....	Compagnie Francaise de Raffinage
Societe Nationale Repal	Hassi Er R'Mel	Gas Separation & Drying	140 MMcf	$2,400,000	Under Constr	1961	.....	Technip	Staff
	Hassi Messaoud	Refinery, Storage	.....	.....	Planning	.....	.....	Lummus	Lummus
CANARY ISLANDS									
Compania Espanola de Petroleos, S.A.	Teneriffe	Crude Distillation	50,000 bbls	$6,000,000	Under Constr	Late 1961	UOP	Procon	Procon
		Unifiner-Platformer	15,000 bbls		Under Constr	Late 1961	UOP	Procon	Procon
		Boilers, Turbogenerators, Tanks			Under Constr	1962	AEG & VKW	AEG & VKW	AEG & VKW
		Merox	4,000 bbls	.....	Planning	.....	.....	.....	.....
		Kerosine, SO_2 Extraction	3,500 bbls	$1,000,000	Engineering	1962	Badger Mfg	Badger Mfg	Badger Mfg
		Vacuum Distillation	7,800 bbls	.....	Under Constr	Mid 1961	.....	Foster Wheeler	Foster Wheeler

*First appearance in tabulation.

HPI CONSTRUCTION BOXSCORE—*Continued*

COMPANY	Plant Site	Project	Daily Capacity	Estimated Cost	Status	Probable Completion	Licensor	Engineering	Contractor
EGYPT									
Anglo-Egyptian Oilfields	Suez	Cat Reformer	2,300 bbls	.....	Planning	.....	.....	.....	.....
Egyptian Chem. Ind./KIMA S.A.E.	Aswan	Ammonia	415 tons	$48,000,000	Under Constr	1961	Uhde/BASF	Uhde/BASF	Uhde/BASF
Egyptian Government	Suez	Atmospheric Distillation, Vacuum Distillation & Lube Oil	20,000 bbls	$7,000,000	Planning	.....	.....	.....	.....
		Cat Reformer	3,000 bbls	$2,700,000	Planning	1962	.....	.....	.....
		Hydrodesulfurizer	2,700 bbls	$720,000	Planning	1962	.....	.....	.....
		Lube Oils	.....	$9,000,000	Planning	1963	.....	.....	.....
		H_2S Removal, Gas Compression	.....	.....	Planning	.....	.....	Lummus	Lummus
	Alexandria	Atmospheric & Vacuum Distillation	10,000 bbls	$1,400,000	Planning	.....	.....	.....	.....
	Cairo	Atmospheric & Vacuum Distillation	10,000 bbls	$1,400,000	Planning	.....	.....	.....	.....
KENYA									
British Petroleum/Shell	Mombasa	Refinery	40,000 bbls	.....	Planning	1964	.....	.....	.....
MOROCCO									
Ente Nazionale Idrocarburi	Mohammedia	Refinery	25,000 bbls	.....	Under Constr	1962	.....	.....	.....
MOZAMBIQUE									
Sociedade Nacional de Refinacao de Petroleos	Lourenco Marques	Refinery:	.....	.....	Under Constr	1961	.....	Procon	Procon
		Crude	12,000 bbls	.....	.....	.....	.....	.....	.....
		Platformer	2,500 bbls	.....	.....	.....	.....	.....	.....
		Unifiner	2,000 bbls	.....	.....	.....	.....	.....	.....
		Merox	1,500 bbls	.....	.....	.....	.....	.....	.....
NIGERIA									
British Petroleum/Shell	Port Harcourt	Refinery	20,000 bbls	$33,600,000	.....	.....	.....	.....	.....
SOUTH AFRICA									
AE & CI	Modderfontien	Synthetic Ammonia	70,000 tons	.....	Under Constr	.....	.....	Staff/ICI/Power-Gas	Power-Gas
British Petroleum/Shell	Durban, Natal	Refinery	60,000 bbls	$70,000,000	Planning	1963	.....	.....	.....
Phillips Petroleum-Industrial Development	.....	Carbon Black	22,000,000 lbs/yr	.....	Under Constr	.....	Staff	Staff	Staff
S.A. Coal, Oil & Gas	.....	Hydrogen	.....	.....	Engineering	.....	Hercules	Power-Gas	.....
South African Petroleum Refineries	Durban	*Refinery	62,000 bbls	.....	Planning	1964	.....	.....	.....



Middle East

COMPANY	Plant Site	Project	Daily Capacity	Estimated Cost	Status	Probable Completion	Licensor	Engineering	Contractor
IRAN									
Iranian Govt.	Shiraz	Nitric Acid	30,000 tons/yr	$30,000,000	Under Constr	.....	SBA	SBA/Foster Wheeler	CJB
		Ammonium Nitrate	.....	.....	Under Constr	.....	SBA	SBA/Foster Wheeler	.....
Iranian Oil Refining	Abadan	Cat Reformer	20,000 bbls	$5,000,000	Engineering	Spring 1962	UOP	Fluor	Fluor
IRAQ									
Iraq Petroleum	Kirkuk	Oil Sweetening	250,000 bbls	$1,250,000	Under Constr	Oct 1961	.....	Staff/Foster Wheeler	Foster Wheeler
		Oil Sweetening	400,000 bbls	.....	Under Constr	Jan 1962	.....	Staff/Foster Wheeler	Foster Wheeler
KUWAIT									
American Independent Oil	.....	*Crude Stabilizer	.....	.....	Under Constr	1962	.....	Parsons	Parsons
Kuwait Oil	Mina al Ahmadi	Bulk LPG	6,500 bbls	.....	Under Constr	Late 1961	.....	Wimpey-Bechtel International	Kuwait Bechtel
PAKISTAN									
Pakistan Industrial Development	Fnchanj	Ammonia	225 tons	$20,000,000	Engineering	1961	Kobe Steel	Chemico	Chemico
		Urea	375 tons	.....	.....	.....	.....	.....	.....
Pakistan Refinery/Shell	Karachi	Refinery: Crude Distillation Hydrotreater Platformer	34,030 bbls	.....	Under Constr	Early 1963	.....	Kellogg	Kellogg International
Standard Vacuum Oil, et al	Korangi	Refinery: Crude Distillation Hydrotreater Catalytic Reformer	32,000 bbls	$35,000,000	Engineering	.....	.....	.....	.....
Sui Carbon	.....	Carbon Black	36,000,000 lbs/yr	.....	Planning	.....	.....	.....	.....
SAUDI ARABIA									
Arabian American Oil	Ras Tanura	LPG	1,500 bbls	$1,025,000	Complete	.....	Kellogg	Staff	Staff
		Asphalts	.....	.....	Under Constr	.....	.....	.....	.....
		Refrigerated LPG	4,000 bbls	$6,600,000	Under Constr	1961	.....	Staff	Staff
United Arab Republic	Suez	Refinery: Atmospheric & Vacuum Distillation	20,000 bbls	$3,000,000	Under Constr	1962	.....	Techno-Export	Techno-Export
		Lube Oils	4,000 bbls	$12,000,000	Engineering	1963	.....	Tiajpromexport	Tiajpromexport
		Vapor Recovery	2,500 bbls	$1,500,000	Under Constr	1962	.....	Lummus	Lummus
		Delayed Coker, Cat Reforming	20,000 bbls 9,700 bbls	$60,000,000	Under Constr	1963	UOP/Engelhard	Braun	CTIP
Arabian Oil of Japan	Kuwait	Topping & Utilities	20,000 bbls	.....	Planning	1962	.....	.....	.....
		Refinery	50,000 bbls	.....	Planning	1965	.....	.....	.....
TURKEY									
Anadolu Tasfiyehanesi A.S.	Mersin	*Refinery	65,000 bbls	.....	Under Constr	1962	.....	.....	.....
Istanbul Petrol Rafinieri Anonim Sirketi (IPRAS)	Ismit	Refinery: Crude Distillation Naphtha Unifiner Platformer Distillate Hydrotreater Catalytic Cracker	20,800 bbls	$26,000,000	Under Constr	End 1961	.....	Kellogg	Kellogg
Mobil International, Royal Dutch Shell BP	Mersin	Refinery: Crude Distillation, Naptha Pretreating, Naptha Catalytic Reforming, Kerosine Catalytic Hydrodesulfurization	65,000 bbls	$48,000,000	Under Constr	End 1961	.....	Foster Wheeler	Foster Wheeler

*First appearance in tabulation.

Far East

COMPANY	Plant Site	Project	Daily Capacity	Estimated Cost	Status	Probable Completion	Licensor	Engineering	Contractor
FORMOSA									
Chinese Petroleum	Kaohsiung	Catforming	5,000 bbls	.....	Engineering	.....	Engelhard	Fluor/Staff	Staff
Pioneer Chemical	Taipei	Coal Tar Distillation	36 tons	.....	Under Constr	Aug 1961	.....	Ishii Iron Works	.....
INDIA									
Fertilisers & Chemicals Travancore	Alwaye, Kerala State	Partial Oxidation Gasification	.....	.....	Engineering	June 1962	Texaco	Power-Gas	Power-Gas
		Carbon Monoxide Pressure Conversion	.....	.....	Engineering	.....	Power-Gas	Power-Gas	Power-Gas
		Carbon Dioxide & Hydrogen Sulfide Removal	.....	.....	Engineering	.....	Power-Gas	Power-Gas	Power-Gas
	Barauni	Refinery	40,000 bbls	.....	Planning	1962	.....	USSR Govt	USSR Govt
Fertilizer Corp. of India	Nahorkatiya, Assam	*Ammonium Sulfate *Urea	155 tons 155 tons	.....	Under Constr	June 1964	Indian Govt	.....	.....
Firestone Tire & Rubber	Bareilly	Synthetic Rubber	30,000 tons/yr	.....	Under Constr	1962	.....	Lummus	Lummus
		Styrene	9,000 tons	$2,500,000	Engineering	Late 1962	Chemische Werke Huls	Firma Carl Still	Staff
Hindustan Steel	Rourkela	Ammonia	514 tons	.....	Under Constr	1961	Uhde	Uhde	Uhde
Neyveli Lignite	Neyveli	Urea	500 tons	$52,500,000	Engineering	Early 1963	.....	Montecatini/ Pintschbamag	Montecathi/ Pintschbamag
Oil India Private	Nunmati (Assam)	Refinery	750,000 tons/yr	$10,500,000	Under Constr	1961	Indian Govt	Rumanian Govt	Rumanian Govt
Phillips Carbon Black	Durgapur	Carbon Black	30,000,000 lbs/yr	.....	Under Constr	June 1962	Phillips Petroleum	Phillips Petroleum/Snam Progetti	SnamProgetti
Sahu Chemicals	Varanasi	Ammonia	120 tons	.....	Under Constr	.....	John Thompson	CECIP	John Thompson
	Sahupuri	*Amonia	40 tons	.....	Engineering	.....	.....	.....	.....
JAPAN									
Asahi Glass	Osaka	Propylene Oxide	320 tons/month	.....	Under Constr	May 1962	Staff	JGC	JGC
		Propylene Glyco	200 tons/month	.....	Under Constr	May 1962	Staff	JGC	JGC
Asia Oil	Yokohama	Unifiner	3,000 bbls	$1,000,000	Engineering	Sept 1961	UOP	UOP/JGC	JGC
		Unifiner-Platformer	5,000 bbls	$3,770,000	Engineering	Sept 1961	UOP	UOP/JGC	JGC
		Merox	4,000 bbls	$119,000	Engineering	1961	UOP	UOP/JGC	JGC
		Topping Desalter	30,000 bbls	$1,980,000	Engineering	1961	.....	Chiyoda	Chiyoda
		Gas Concentration	1.6 MMcf	$511,000	Engineering	Sept 1961	.....	UOP/JGC	JGC
Chubu Gas	Chubu	Catalytic Oil Gazification	1 MMcf	.....	Engineering	Dec 1961	Onia Gegi	H & G	Ishii Iron
Daikyo Oil	Yokkaichi	Furfural	1,500 bbls	$835,000	Planning	Nov 1961	Texaco	Texaco/ Chiyoda	Chiyoda
Dai Nippon Chemical	Ikuna	Butanol	.....	.....	Planning	.....	Hoechst	Uhde	Uhde
	Otake	Butanol	1,000 tons/ month	.....	Engineering	Feb 1962	Hoechst	Uhde/JGC	JGC
		Crotonaldehyde	1,730 tons/ month	.....	Engineering	Feb 1962	Hoechst	Uhde/JGC	JCG
		Methoxybutanol	140 tons/month	.....	Engineering	Feb 1962	Hoechst	Uhde/JGC	JGC
Furukawa Chemical Industries	Japan	Platforming	5,000 bbls	.....	Planning	.....	UOP	UOP/JGC	.....
Fuji Iron & Steel	Himeji	Unifining, Udex	700 bbls	.....	Under Constr	1961	UOP	UOP/JGC	JGC
General Oil	Kawasaki	Merox	5,700 bbls	.....	Engineering	Oct 1961	UOP	UOP/JGC	JGC
		*Desalter	38,000 bbls	.....	Complete	.....	Petreco	Petreco/ Chiyoda	Chiyoda
		*Electrofiner	4,000 bbls	.....	Complete	.....	Petreco	Petreco/ Chiyoda	Chiyoda
General Sekiyu	Kawasaki	Unifiner-Platformer	6,000 bbls	.....	Planning	.....	UOP	UOP/JGC	JGC
Idemitsu Kosan	Chiba	Unifiner-Platformer	9,000 bbls	.....	Planning	.....	UOP	UOP/JGC	JGC
		Merox	5,000 bbls	.....	Planning	.....	UOP	UOP/JGC	JGC
		Desalter	100,000 bbls	$150,000	Engineering	Feb 1962	Petreco	Petreco/ Chiyoda	Fujinagata/ Chiyoda
		Unifiner	10,000 bbls	.....	Planning	.....	UOP	JGC	JGC
		Gas Conditioning	.....	.....	Planning	.....	UOP	JGC	JGC
Japan Petrochemical	Tokyo	*CO_2 Removal	374 Mcf	$30,000	Under Constr	1961	.....	Tears	Iino-Tears
Japan Synthetic Rubber	Yokkaichi	Exp. Synthetic Butadiene Rubber	5,000 tons/yr	.....	Engineering	Dec 1961	Goodyear	JGC	JGC
		Exp. Butadiene	5,000 tons/yr	.....	Engineering	Oct 1961	Esso	JGC	JGC
		Butyl Rubber	5,000 tons/yr	.....	Planning	March 1962	Esso	.....	.....
		Iso-Butylene	30,000 tons/yr	.....	Planning	Dec 1962	.....	.....	.....
		cis-Polybutadiene	.....	.....	Planning	.....	.....	.....	.....
		Carbon Black Masterbatch	10,000 tons/yr	.....	.....	.....	Columbia	.....	.....
Karonite Chemical	Kawasaki	*Lube Oil Additives	2,000,000 gals/yr	$2,000,000	Engineering	Mid 1962	Cal Chemical	.....	.....
Kos Oil	Iwakuni	Merox	.....	.....	Planning	.....	UOP	UOP/JGC	JGC
		Topping-Vacuum	55,000 bbls	$42,000,000	Complete	.....	.....	JGC	JGC
		Unifining	10,000 bbls	$2,500,000	Engineering	June 1962	UOP	UOP/JGC	JGC
		Udex	2,500 bbls	.....	Planning	Late 1962	UOP	UOP/JGC	JGC
	Marifu	Crude	40,000 bbls	.....	Complete	.....	UOP	JGC	JGC
		Unifiner	10,000 bbls	$2,500,000	Engineering	June 1962	UOP	UOP/JGC	JGC
		Udex	2,500 bbls	$2,800,000	Planning	.....	UOP	UOP/JGC	JGC
Kokan Chemical Industries	Kawasaki	Ethylbenzene	21,000 tons/yr	.....	Engineering	Oct 1961	UOP	UOP/JGC	JGC
		Styrene Monomer	13,000 tons/yr	.....	Engineering	Oct 1961	UOP	UOP/JGC	JGC
		Unifiner	450 bbls	.....	Planning	.....	UOP	UOP/JGC	JGC
Kureha Chemical	Nakoso City	*Perchloroethylene	.....	.....	Under Constr	.....	SD	SD	.....
Kyowa Gas	Nigatta	Acetylene	60 tons	.....	Engineering	Early 1962	BASF	Chemico	Staff
		Methanol	220 tons	.....	Engineering	Early 1962	Chemico	Chemico	Staff
Kyowa Hakko Kogyo		Acetaldehyde	.....	.....	Planning	.....	Aldehyde	Uhde	Uhde
Marusen Oil	Goi	Atmospheric & Vacuum Crude Distillation	100,000 bbls	.....	Planning	March 1962	.....	Texaco/ Chiyoda	Chioyda
	Shimotsu	Unifiner-Platformer	6,000 bbls	.....	Complete	.....	UOP	UOP/JGC	JGC
		Unifiner	4,500 bbls	.....	Complete	.....	UOP	UOP/JGC	JGC
	Chiba	Desalter	100,000 bbls	.....	Engineering	Sept 1962	.....	.....	.....
		Topping	100,000 bbls	.....	Engineering	Sept 1962	.....	Staff	.....
		Unifiner-Platformer	10,000 bbls	.....	Engineering	Sept 1962	UOP	UOP/JGC	JGC
		Unifiner	5,000 bbls	.....	Engineering	Sept 1962	UOP	UOP/JGC	JGC
		Merox	2,500 bbls	.....	Engineering	Sept 1962	UOP	UOP/JGC	JGC
		Gas Recovery	4,500 bbls	.....	Engineering	Sept 1962	.....	Staff	.....
Miike Gosei Chemical	Omuta City, Kyushu	*Maleic Anhydride	8,000,000 lbs/yr	.....	Under Constr	.....	SD	SD	.....
Mitsubishi Oil	Mizushima	Desalter	22,000 bbls	$3,000,000	Complete	.....	Petreco	Petreco/ Chiyoda	Chiyoda
		Atmospheric & Vacuum Crude Distillation	40,000 bbls		Complete	.....	Petreco	Chiyoda	Chiyoda
		Unifiner-Platformer	3,600 bbls	$1,400,000	Under Constr	Sept 1961	UOP	Chiyoda/ JGC/UOP	Chiyoda

*First appearance in tabulation.

HPI CONSTRUCTION BOXSCORE—*Continued*

COMPANY	Plant Site	Project	Daily Capacity	Estimated Cost	Status	Probable Completion	Licenser	Engineering	Contractor
Mitsubishi (Cont.)		Unifiner	7,200 bbls	$800,000	Under Constr	Sept 1961	UOP	Chiyoda/ JGC/UOP	Chiyoda
		Merox	2,000 bbls	$140,000	Complete	.....	UOP	Chiyoda/ JGC/UOP	Chiyoda
		Unifiner	4,200 bbls	$1,260,000	Planning	Feb 1962	UOP	Chiyoda/ JGC/UOP	Chiyoda
		Hydrogen	5,900,000 scf	$1,480,000	Planning	March 1962	.....	Chiyoda	Chiyoda
		Cat Cracking	7,600 bbls	$2,710,000	Planning	Feb 1962	.....	Chiyoda	Chiyoda
		*Fluid Coker	5,600 bbls	$3,720,000	Planning	Mar 1962	Esso	Chiyoda/Esso	Chiyoda
		Gas Recovery	801,000 bbls	$2,300,000	Planning	Feb 1962	.....	Chiyoda	Chiyoda
		Sulfur Recovery	68 tons	$680,000	Planning	March 1962	.....	Chiyoda	Chiyoda
		H_2S Scrubber	171,000 lbs	$380,000	Planning	March 1962	.....	Chiyoda	Chiyoda
	Kawasaki	Stabilizer & Depropanizer	5,000 bbls	$280,000	Under Constr	1961	.....	Chiyoda	Chiyoda
		Atmospheric & Vacuum Crude Distillation	3,500 bbls	.....	Planning	Mar 1962	.....	Chiyoda	Chiyoda
Mitsubishi Petrochemical	Yokkaichi	Unifiner-Udex	1,606 bbls	.....	Complete	.....	UOP	UOP/JGC	JGC
		Ethylene	22,000 tons/yr	.....	Under Constr	July 1961	S & W	S & W/JGC	JGC
		Polyethylene	15,000 tons/yr	.....	Under Constr	July 1961	BASF	BASF/Mitsubishi Chemical Machinery	Mitsubishi Chemical Machinery
		*Polypropylene	10,000 tons/yr	.....	Under Constr	March 1962	Montecatini	Montecatini	Chiyoda
		*Epoxy Resins	4,000 tons/yr	.....	Under Constr	Dec 1961	Shell	BICM	Mitsubishi Chemical Machinery
		*Petroleum Resins	4,000 tons/yr	.....	Planning	Dec 1961	.....	.....	.....
		Alkylbenzene	15,000 tons/yr	.....	Planning	.....	UOP/SIR	UOP/BICM	.....
		Styrene Monomer	15,000 tons/yr	.....	Complete	.....	.....	Chiyoda	Chiyoda
Mitsui Petrochemicals	Otake	Ethylene	20,000 tons/yr	.....	Engineering	Feb 1962	S & W	S & W/Mitsui Shipbuilding	Mitsui Shipbuilding
		Unifiner	1,700 bbls	.....	Planning	Feb 1962	S & W	S & W/Mitsui Shipbuilding	Mitsui Shipbuilding
		Acetaldehyde	24,000 tons/yr	.....	Engineering	Feb 1962	Hoechst	Uhde/JGC	JGC
		Hydrogen	.....	.....	Engineering	Feb 1962	Nippon Gas Chemical/ JGC	JGC	JGC
	Ikuna	Acetaldehyde	.....	.....	Planning	.....	Aldehyd	Uhde	Uhde
New Asia Oil	Yokohama	Unifiner	3,000 bbls	.....	Engineering	Sept 1961	UOP	UOP/JGC	JGC
		Unifiner-Platformer	5,000 bbls	.....	Engineering	Sept 1961	UOP	UOP/JGC	JGC
		Gas Concentration	1.6 MMcf	.....	Engineering	Aug 1961	UOP	UOP/JGC	JGC
Nichimo Oil	Kawasaki	*Electrofiner	1,900 bbls	.....	Complete	.....	Petreco	Petreco/ Chiyoda	Chiyoda
Nihon Synthetic Rubber	Yokkaichi	Exp. Petrochemicals	to 45,000 tons/yr	.....	Under Constr	1963	.....	.....	.....
Nippon Mining	Misushima	Unifiner	2,000 bbls	.....	Under Constr	1961	UOP	UOP/JGC	JGC
		Unisol	2,500 bbls	.....	Under Constr	1961	UOP	UOP/JGC	JGC
		Cat Reforming	6,000 bbls	.....	Under Constr	1961	Houdry	Houdry	Houdry
		Hydrodesulfurization	8,000 bbls	.....	Under Constr	1961	.....	Catalytic/ Niigata	Catalytic/ Niigata
		Crude Distillation	30,000 bbls	.....	Under Constr	1961	.....	Fujinagata	Fujinagata
		Topping	30,000 bbls	.....	Under Constr	1961	.....	Fujinagata	Fujinagata
		No. 2 Unifiner	2,000 bbls	.....	Under Constr	1961	UOP	UOP/JGC	JGC
Nippon Petroleum Detergent	Kawasaki	*Detergent Alkylate	33,075 tons/yr	$5,000,000	Engineering	Early 1962	Cal Chemical	.....	.....
Nippon Petrochemicals/Oronite Chemical	Kawasaki	Alkyl Benzene	15,000 tons	$4,000,000	Engineering	Late 1961	Cal Research	Standard-Cal	Niigata
		Unifiner-Udex	800 bbls	$3,700,000	Engineering	Aug 1961	UOP	UOP/JGC	UOP/JGC
		Isopropanol	6,000 tons/yr						
		Acetone	6,000 tons/yr	$2,500,000	Complete	.....	Distiller	S & W	.....
		*Ethylene	40,000 tons/yr	$4,500,000	Complete	.....	S & W	S & W/JGC	.....
		*Ethylene	50,000 tons/yr	.....	Planning	Spring 1962	S & W	S & W/JGC	.....
Nippon Petroleum Refining	Yokohama	Cat Cracker	7,500 bbls	.....	Under Constr	Nov 1961	UOP	UOP/JGC	JGC
Nitto Chemical Industry	Yokohama	*Synthesis Gas	232 tons	$6,600,000	Engineering	Spring 1962	Texaco	Tears	Iino-Tears
Nitto Unicar	Kawasaki	Polyethylene	27,000 tons/yr	.....	Engineering	March 1962		JGC	JGC
Okura Trading	Sendai	Catalytic Oil Gasification	0.75 MMcf	.....	Engineering	Nov 1961	Onia Gegi	H & G	Ishii Iron
Osaka Gas	Kobe	Light Distillate & High Gas Reforming	7 MMcf	.....	Under Constr	Oct 1961	Onia Gegi	H & G	Ishii Iron
Shin Nippon Chisso Hiryo	Goi	Polypropylene	13,000 tons/yr	$20,000,000	Engineering	Fall 1962	Avisun	Tears	Iino-Tears
K. K.	.....	Acetaldehyde	.....	.....	Planning	.....	Aldehyd	Uhde	Uhde
Showa Denko KK	Tokyo	Carbon Black	.....	.....	Under Constr	.....	Phillips	.....	.....
	Kawasaki	Acetaldehyde	.....	.....	Planning	.....	Aldehyd	Uhde	Uhde
Showa Oil	Kawasaki	Unifiner-Platformer	6,000 bbls	.....	Engineering	Oct 1961	UOP	UOP/JGC	JGC
		Merox	4,000 bbls	.....	Engineering	Aug 1961	UOP	UOP/JGC	JGC
Sumitomo Chemical/ SBA	Niihama City	Acetylene-Ethylene	.....	.....	Engineering	.....	SBA	SBA	.....
		Ethylene	25,000 tons/yr	.....	Engineering	.....	S & W	.....	.....
		Unifiner-Udex	1,000 bbls	.....	Planning	.....	UOP	UOP/JGC	JGC
		Alkylbenzene	10,000 tons/yr	.....	Planning	.....	UOP	.....	.....
Toa Nenryo	Kawasaki	Fired Heater	1.8 MM Btu/hr	$6,500	Under Constr	1961	.....	Tears	Iino-Tears
Toa Oil	Kawasaki	Desalter	30,000 bbls	$100,000	Engineering	Sept 1961	Petreco	Petreco/ Chiyoda	JGC/Chiyoda
		Merox	5,000 bbls	.....	Engineering	.....	UOP	UOP/JGC	JGC
		Unifiner-Platformer	5,000 bbls	.....	Engineering	.....	UOP	UOP/JGC	JGC
		Gas Concentration	14,000 lbs/yr	.....	Engineering	Mar 1962	.....	JGC	JGC
Tokai Ryuan K.K.K.	.....	High Pressure H_2S & CO Conversion, CO_2 Removal	500,000 cu ft/hr	.....	Engineering	.....	Power-Gas/ Ventrocoke	Power-Gas	Mitsubishi KK
Tonen Petrochemicals	Kawasaki	Butadiene	18,742 tons/yr	.....	Under Constr	March 1962	Esso	Chiyoda/Staff	Chiyoda/Staff
		*Ethylene	40,000 tons/yr						
		*Butadiene	7,000 tons/yr	$25,000,000	Under Constr	1962	Esso	Esso/Staff	Staff
Toshiba Electric	Himeji	*Catalytic Oil Gasification	0.5 MMcf	.....	Engineering	Dec 1961	Onia Gegi	H & G	Ishii Iron
Toyo Koatsu	Muroran	Alkar	17,250 tons/yr	.....	Planning	May 1962	UOP	UOP	.....
		Styrene	15,000 tons/yr	.....	Planning	May 1962	UOP	UOP	JGC
Ube Kosan	.....	Ammonia	100 tons	.....	Under Constr	.....	.....	Chemico	Chemico
		Ethylene	21,000 tons/yr						
		Polyethylene	20,000 tons/yr	.....	Planning	.....	.....	.....	.....
		Polypropylene	5,000 tons/yr						
	Chiba	Alkylbenzene	10,000 tons/yr	.....	Planning	.....	UOP	.....	.....
KOREA									
Korean Government	Naju	Urea	95,000 tons/yr	.....	Under Constr	1962	Inventa	Lurgi/Uhde	Lurgi/Uhde
Korea Petroleum	Ilsan	Refinery	20,000 bbls	.....	Planning	.....	.....	.....	.....
MALAYA									
Maruzen Toyo Oil (Singapore)	Pasir Panjang	Refinery	20,000 bbls	.....	Under Constr	Dec 1961	.....	.....	.....

*First appearance in tabulation.

HPI CONSTRUCTION BOXSCORE—*Continued*

COMPANY	Plant Site	Project	Daily Capacity	Estimated Cost	Status	Probable Completion	Licensor	Engineering	Contractor
Shell Refining (Malaya)	Port Dickson	*Refinery	20,000 bbls	.....	Planning	Mid 1964	.....	.....	.....
Shell Refining (Singapore)	P. Bukom	Refinery	20,000 bbls	.....	Under Constr	Sept 1961	.....	.....	.....
Standard Vacuum....	Port Dickson	Refinery, Chemical Fertilisers	.....	.....	Planning	1964	.....	Lummus	Lummus
THAILAND									
Thai Defense Ministry	Bangkok	Refinery	5,000 bbls	$20,000,000	Engineering	July 1962	Houdry/ Phillips	Hydrocarbon	Japanese Fuji

Australasia

COMPANY	Plant Site	Project	Daily Capacity	Estimated Cost	Status	Probable Completion	Licensor	Engineering	Contractor
AUSTRALIA									
Australia Lubricating Oil Refinery	Kurnell	*Vacuum Distillation	.....	.....	.....	.....	.....	.....	.....
		*Furfural Extraction	140,000 tons/yr	.....	Engineering	.....	Texaco	Foster Wheeler	Staff
		*Hydrotreating	.....	.....	.....	.....	.....	.....	.....
		*MEK Dewaxing	.....	.....	.....	.....	.....	.....	.....
Australian Oil Refining	Kurnell	Exp. Refinery:	.....	.....	Complete	.....	UOP/ Kellogg	Kellogg/Staff	Staff
		Crude	45,000 bbls	.....	Complete	.....	.....	.....	.....
		Cat Cracker	18,000 bbls	.....	Complete	.....	.....	.....	.....
		Alkylation	3,400 bbls	.....	Complete	.....	.....	.....	.....
Australian Synthetic Rubber	Altona	Synthetic Rubber	30,000 tons/yr	$10,000,000	Under Constr	Fall 1961	Goodyear	Fluor	Fluor/Utah
Bitumen & Oil Refineries	Sydney	Diesel Unifiner	2,500 bbls	.....	Under Constr	.....	.....	UOP	Staff
		Crude	12,000 bbls	.....	Planning	.....	.....	Procon	Procon
	Matraville	*Udex	1,000 bbls	$1,100,000	Under Constr	1961	UOP	Procon	Procon
		*Cat Cracking, Concentration Polymerization	4,500 bbls	$4,000,000	Under Constr	Dec 1961	UOP	Procon	Procon
British Petroleum....	Kwinana	Lube Oils	100,000 tons/yr	.....	Engineering	End 1962	Texaco	Foster Wheeler/ CJB	Foster Wheeler/ CJB
Colonial Gas	Box Hill	Blue Water Gas	1.5 MMcf	.....	Complete	.....	H & G	H & G	H & G
CSRC Dow Pty.....	Altona	Styrene	.....	$6,500,000	Under Constr	July 1961	Dow	Bechtel/McDonald/Wimpey & Coy	Bechtel/McDonald/Wimpey & Coy
		Ethylene Dichloride	.....	.....	Under Constr	1961	.....	Bechtel/ McDonald/ Wimpey	Bechtel/ McDonald/ Wimpey
Gas & Fuel.....	Melbourne	Catalytic Oil Gasification & Gas Reforming	10 MMcf	.....	Engineering	1962	Onia Gegi	H & G	H & G
Geelong Gas.....	Geelong	Refinery Gas Reforming	3 MMcf	.....	Under Constr	1961	Onia Gegi	H & G	H & G
Shell Chemical.....	Clyde	Resins, Alkylates	.....	$22,000,000	Planning	.....	.....	.....	.....
		Cat Cracker	.....	$38,000,000	Under Constr	1963	.....	.....	.....
		Ethylene	.....	$22,400,000	Under Constr	Early 1962	.....	Braun	Braun
Shell Oil.....	Newport	Oil Blending	.....	.....	.....	.....	.....	.....	.....
Shell Refining (Australia)	Clyde	Cat Cracker	24,000 bbls	.....	Under Constr	Late 1962	.....	.....	.....
	Geelong	Hydrodesulfuriser	11,000 bbls	.....	Planning	.....	.....	.....	.....
Standard Vacuum...	Adelaide	Refinery	40,000 bbls	$30,000,000	Engineering	1962	.....	Kellogg	Kellogg
	Altona	Petrochemicals (Ethylene & Butadiene)	20,000 tons/yr	$28,000,000	Under Constr	1961	Esso	Fluor	Fluor/Utah
	Port Noarlunga, near Adelaide	*Refinery: Crude Splitter Vacuum Still Hydrodesulfurization Cat Reforming Sulfur Recovery	37,800 bbls	.....	Engineering	Early 1963	.....	Kellogg	Kellogg
Union Carbide.....	Melbourne	Polyethylene	15,000,000 lbs/yr	$6,500,000	Planning	1961	.....	.....	.....
NEW ZEALAND									
New Zealand Refining (BP, Caltex, Europa, Shell, Stanvac)	Whangerei	Crude Distillation, Cat Reforming, Gas Oil Desulfurization, Bitumen	50,000 bbls	.....	Planning	.....	.....	.....	.....
PHILIPPINE ISLANDS									
Filoil Refining.....	Luzon	Refinery	10,000 bbls	.....	Planning	.....	.....	.....	.....
Shell (Philippines)....	Manila	Refinery	25,000 bbls	.....	Under Constr	1962	.....	Bechtel	Bechtel
	Tabangao	Refinery	25,500 bbls	.....	Under Constr	Mid 1962	.....	.....	.....

*First appearance in tabulation.

Boxscore Abbreviations

Badger N. V.—Badger N. V., Netherlands
Badger Mfg.—Badger Mfg. Co.
B & R—Brown & Root, Inc.
BASF—Badische Anilin & Sod. Fab.
Bechtel—Bechtel Corp.
BICM—Bataafse Internationale Chemie Maatschappij
Blaw-Knox—Blaw-Knox Co.
Braun—C F Braun Co.
Calif. Res.—California Research Corp.
Canadian Badger—Canadian Badger Company Limited
Canadian Bechtel—Canadian Bechtel Limited
Catalytic—Catalytic Construction Co.
Chemico—Chemical Construction Co.
Chiyoda—Chiyoda Chemical Engineering & Construction Co.
C&I—The Chemical and Industrial Corp.
CJB—Constructors John Brown, Ltd.
CTIP—Compagnia Technica Industria Petroli
Dresser—Dresser Engineering Corp.
Ehrhart—Ehrhart & Associates, Inc.
Esso—Esso Research and Engineering Co.
Ferguson—H. K. Ferguson Co.
Fluor—Fluor Corp.
Food—Food Machinery & Chem. Corp.
Foster Wheeler—Foster Wheeler Corp.
Fried. Krupp—Fried. Krupp Industriebau
Girdler—The Girdler Corp.
Heurtey—Societe Anonyme Heurtey
H & G—Humphrey & Glasgow
Hudson—Hudson Engineering Corp.
Hydrocarbon—Hydrocarbon Research, Inc.
ICI—Imperial Chemical Industries, Ltd.
Iino-Tears—Iino Shipbuilding & Engineering Co., Ltd., and Tears Engineers, Inc.
JGC—Japan Gasoline Co.
Kellogg—The M. W. Kellogg Co.
Kidde Constr.—Walter Kidde Constructors, Inc.
Kidde Engrs.—Walter Kidde Engineers Southwest, Inc.
Koppers—Koppers Co., Inc.
Litwin—Litwin Engineering Co.
Lummus—The Lummus Co.
Lurgi—Lurgi G. m. b. H.
McKee—Arthur G. McKee Co.
MHW—McKee-Head Wrightson, Ltd.
Nofsinger—The C. W. Nofsinger Co.
Olsen—O. L. Olsen Co.
Otto—Dr. C. Otto & Comp., G.m.b.H.
Parsons—The Ralph M. Parsons Co.
Pona—Pona Engineers, Inc.
Power Gas—Power Gas Corp., Ltd.
Pritchard—J. F. Pritchard Co.
Procon—Procon, Inc.
Ref-Chem—Refinery Chemical Co.
S&W—Stone & Webster Engineering Corp., Chemical Division
S&W Ltd.—Stone & Webster England, Ltd.
SBA—Soc. Belge de L'Azote et des Produits Chimiques du Marly
SD—Scientific Design
SFST—Societe Francais des Services Techniques
Stearns-Roger—Stearns-Roger Mfg. Co.
Swco—Southwestern Engineering Co.
Tears—Tears Engineers, Inc.
Technic—Compagnie Francaise D'Etudes et de Construction TECHNIP
Tellepsen—Tellepsen Petro-Chem Constructors
Treco—Refinery Engineering Co.
Uhde—Friedrich Uhde, G. m. b. H.
UOP—Universal Oil Products Co.
Vulcan—Vulcan Cincinnati, Inc.

Regular Submersible

SUBMERSIBLE PUMPS

deliver water

economically

consistently

silently

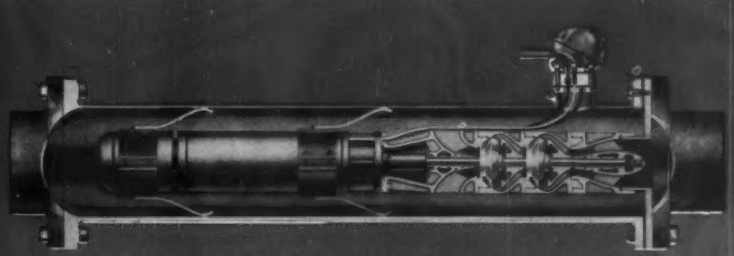
efficiently

The Layne Submersible Pump installation gives you noise free operation because the pump and motor are completely submerged. The Layne Submersible is adaptable to all wells; requires a minimum of space since no pump house is required; eliminates possibility of water contamination; and eliminates the opportunity for vandalism or other accidental mishap or damage.

Layne Submersible Pumps are available for wells as small as 6 inches and in capacities from 30 GPM up. For additional information write for free bulletin number 202.

The Layne In-Line Submersible pump provides the answer to many problems in booster pump applications. The pump operates as an integral part of the line and is designed for use by municipalities, industry, such as petroleum and chemical plants and by agriculture. Advantages include: simple installation, no additional space required, continuous service even under flood conditions, and no possibility of surface water contamination.

Layne In-Line pumps are made as small as 4 inch bowls on a 4 inch motor for use in a 6 inch pipe to deliver 30 GPM. Larger sizes are available as required. For additional information write for free bulletin number 203.



In-Line Submersible

Layne SINCE 1882 — COMPLETE WATER SERVICE

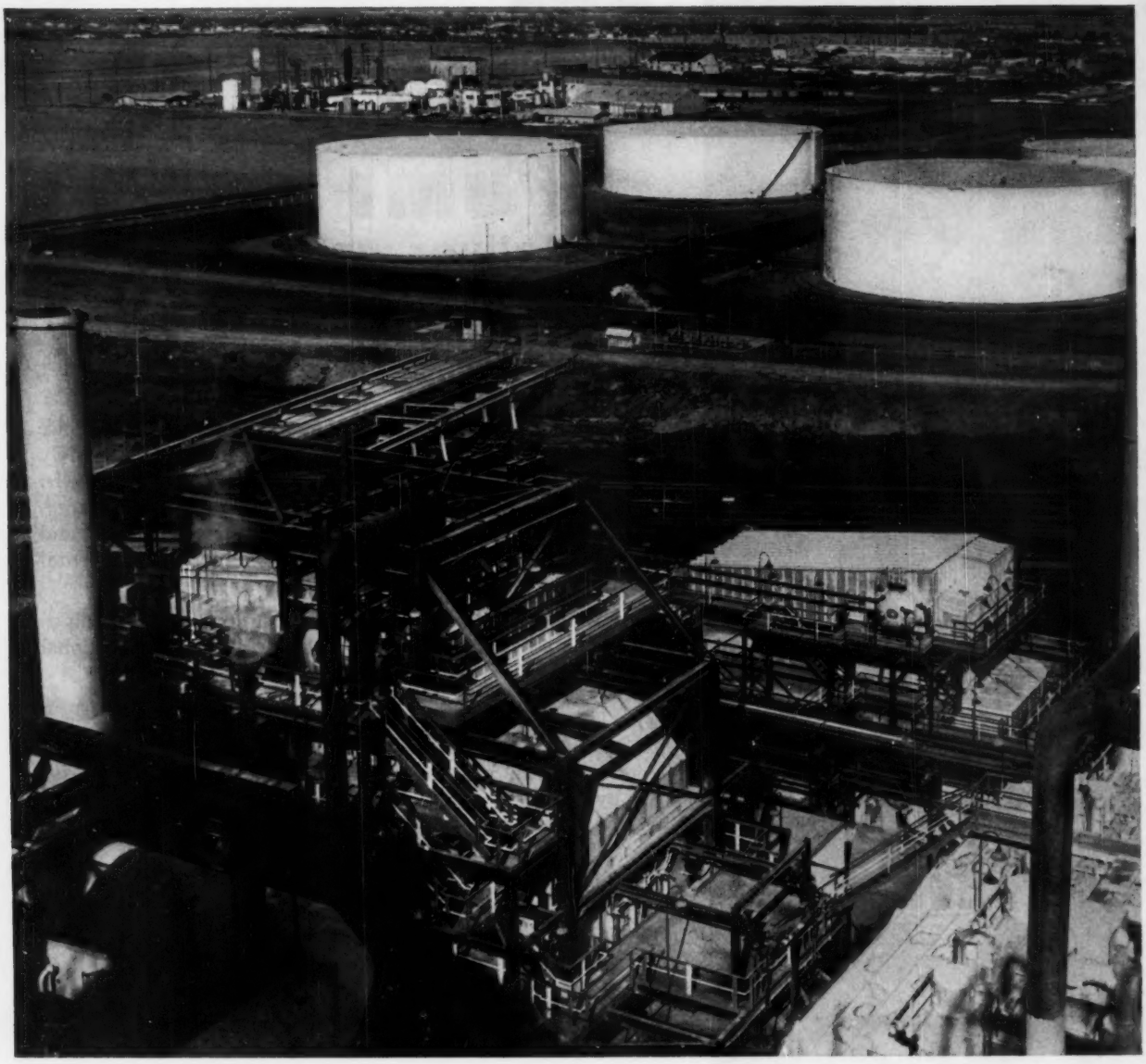
LAYNE & BOWLER, INC., MEMPHIS

General Offices and Factory, Memphis 8, Tenn.

LAYNE ASSOCIATE COMPANIES THROUGHOUT THE WORLD

Sales Representatives in Major Cities

Find LAYNE Fast in the Yellow Pages under pumps



At Richfield Refinery, B&W boiler "team" provides

dependable operation with maximum

Two highly efficient B&W boilers of entirely different designs — system engineered into a money saving "team" — are providing operating flexibility and dependability at Richfield's Wilmington, California refinery.

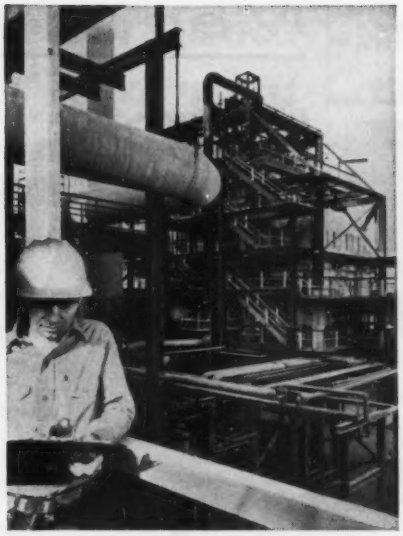
The two boilers are the CO* Boiler, which operates on waste gases from the refinery process, and the PFI, which burns refinery gas, natural gas, or oil with equal ease.

The CO Boiler has been base loaded at 340,000 lbs./hr. full load since its installation in 1954, with an availability exceeding 96%. Developed and pioneered by B&W, the CO Boiler improves refinery economy by burning cat-cracker gas that would otherwise be wasted. The Richfield unit is typical of the many CO Boilers that have solved air pollution problems.

Supplementing the steam produced by the CO Boiler, the PFI boiler is equipped to use the lowest cost auxiliary fuel, whether oil or gas, at all times.

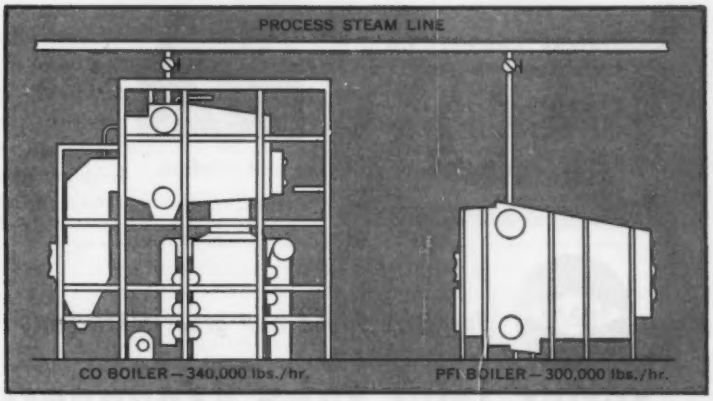
Reg. U.S. Pat. Off.

MAXIMUM AVAILABILITY — No unscheduled outages have occurred since the CO Boiler (left) and the PFI boiler (right) went on the line. This complete freedom from unscheduled shutdowns plus sustained high efficiency provides Richfield with dependable steam at 640,000 lbs./hr.



PAYS FOR ITSELF—Burning cat-cracker gas that would otherwise go up the stack and pollute the atmosphere, the B&W CO Boiler cuts operating costs to the extent that it, and others like it, pay for themselves in fuel savings in less than 3 years.

FLEXIBILITY OF OPERATION — The PFI boiler helps keep steam generation costs down by providing immediately all needed steam in excess of that which can be obtained by burning the waste gas.



EASY TO OPERATE, INTEGRATED CONTROL CENTER—Fully automated control center equipped with Bailey meters ties this boiler "team" together as a dependable source of low cost steam to meet refinery requirements.

fuel savings

This compact, versatile boiler, designed for 300,000 lbs./hr. supplies steam required in excess of that produced from the waste gases, and responds immediately to changing conditions.

By continually developing more efficient and economical ways to generate steam, B&W has helped many industries to meet growing steam demands at lowest possible cost. For further details, contact The Babcock & Wilcox Company, Boiler Division, Barberton, Ohio.

G-990-18

B&W

THE BABCOCK & WILCOX COMPANY

For more data on advertised products, use cards, last page.

Protect Alkylation and Ultraforming Units

against acid corrosion

Wherever acid spills or leaks, as on these pump bases, or where acids attack quench towers, you'll find Sauereisen No. 54 Acid-Proof Concrete providing permanent protection against corrosion, at temperatures to 2000° F. Can be poured into forms or applied as a topping.

Ask for Data Sheets

Sauereisen Cements Co
Pittsburgh 15, Pa.

SAUEREISEN
POUR-LAY CEMENT **No. 54**
PAT. APPLIED FOR

Men in HPI...

John S. Cromie, formerly assistant to the president, Catalytic Construction Co., Philadelphia, has been named general manager of finance for the company. **Walter Cosinuke** has been appointed technical assistant to the president. Previously he had been technical assistant to the manager of construction. **Charles H. Edmondson** has been assigned to manager of maintenance. He had served as manager, Gulf Coast sales.

Cromie

Cosinuke

Edmondson

B. E. Milner, in charge of The Atlantic Refining Co.'s refinery at Port Arthur, Texas, has been named manager, Atlantic's Refinery Supply Department. **A. W. Kusch** will replace Milner as manager of the Port Arthur refinery.

Harold G. Osborn, Houston, a 40-year employe and a director and senior vice president of Continental Oil Co., has retired. Osborn joined Conoco at Ponca City, Okla., in 1921.

Dewey D. Billodeau has been promoted to plant manager, United Carbon Co.'s new $5-million carbon black plant in Port Jerome, near LeHavre in northern France. Billodeau was formerly assistant to the quality control superintendent at the company's headquarters in Houston. He joined United Carbon in 1954 as assistant plant engineer at the carbon black plant, Ivanhoe, La.

Vivian E. Sicks, vice president of Cities Service (Canada), has been named operations manager for Petroquimica Argentina, S.A., owned by Cities Service, Fish International, Continental Oil, U.S. Rubber, and Witco Chemical. Sicks will temporarily headquarter at the firm's New York office. **Harold W. Torgeson,** who has been Conoco's Ponca City refinery manager, will be transferred to the Trafalgar, Ont., plant as manager. **I. W. Scroggin** will succeed Torgeson at Ponca City.

Clifford B. Marshall has been elected president and chief executive officer, Standard-Vacuum Oil Co. Marshall, who was executive vice president, succeeds **Horry F. Prioleau,** who has retired. Both Prioleau and Marshall have been Stanvac directors since 1949.

Francis S. Liggett has been promoted to senior section leader, Union Oil Co. of California's Research Center, Brea, Calif.

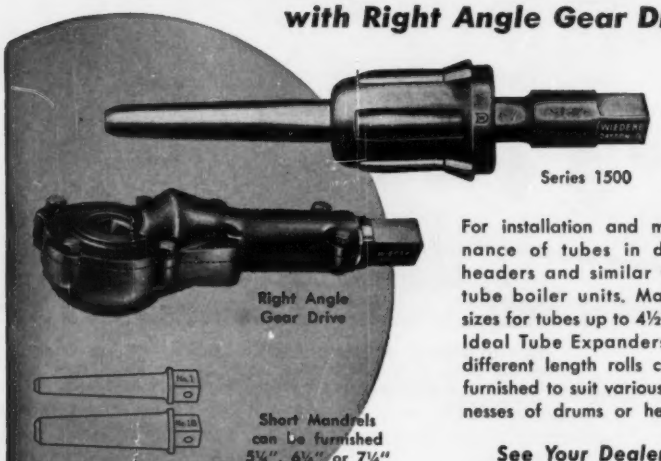
T. L. Satterwhite has been promoted to senior staff engineer, Central Technical Division, Humble Oil & Refin-

IDEAL WIEDEKE DAYTON TUBE EXPANDERS

for more Speed and greater Efficiency

Series 1500 Tube Expanders

with Right Angle Gear Drive



For installation and maintenance of tubes in drums, headers and similar water tube boiler units. Made in sizes for tubes up to 4½" O.D. Ideal Tube Expanders with different length rolls can be furnished to suit various thicknesses of drums or headers.

See Your Dealer or Write Us Today!

THE GUSTAV **WIEDEKE** COMPANY
DAYTON 1, OHIO

How Nalco® High-Performance Coagulants Can Cut Your Water Treatment Cost... And Give You Better Water, Too!

Proper Clarification of Water Delivers Savings Throughout the System

Have you examined your clarification system on a realistic cost-performance basis lately? Have you taken into consideration rising costs of materials *and* labor? Such an analysis is the only valid method of determining what coagulation is costing you today.

Here at Nalco, it has been our experience that high performance Nalco coagulants show up the expense and inefficiency of older coagulation methods. An overall evaluation often shows that the "low-cost-per-pound" coagulants cost more per thousand gallons of clear, sparkling water... (water they will seldom deliver except under ideal conditions).

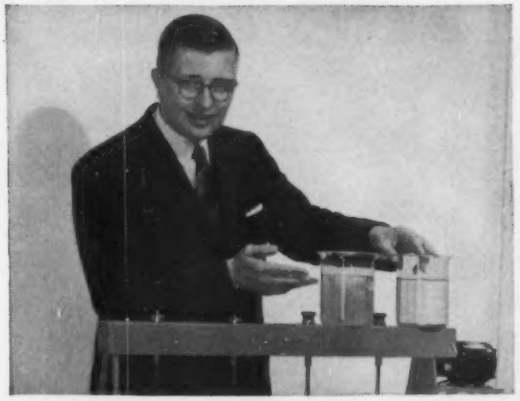
Efficient clarification is extremely important as a safeguard against high treatment costs in your supply lines, process equipment, cooling systems and boilers. Therefore, in assessing a clarification program, *all* factors affecting costs and potential savings must be considered . . . not overlooking freight, storage, feeding and performance figures.

Savings Begin with Chemicals to Fit the Job

Nalco's coagulant and coagulant aid chemicals are designed to fit feeding and water use requirements in both economy and performance. Sodium aluminate coagulants are: No. 2 Liquid, stable, highly-active and simple to proportion and use in liquid feeding equipment; Nalco 680 pure-white powder, ideal for use where chemical color is important; and Nalco 614 granular, high-activity, free-flowing sodium aluminate, used widely in municipal plants and other large-volume treatment applications. Nalco cationic, anionic and non-ionic polymer coagulants and coagulant aids are "heavy-duty" chemicals, used with Nalco sodium aluminates, with alum, or alone, depending upon the particular operating requirements of the system.

Savings Throughout the System

Fast formation of heavy, stable floc with Nalco coagulants and coagulant aids is basic in producing water that is trouble-free in use throughout the system. Some of the more common troubles Nalco-treated water prevent are: solids carryover of floc, sludge or alumina—and resultant plugging of pipes and equipment; corrosive or unstable water; and taste, odor and color carryover. While Nalco high-performance coagulants are not bactericides, bacterial content of efficiently treated water is significantly lower



J. T. Burke, Product Manager of Nalco Coagulant Chemicals Department, is a specialist in water clarification . . . One of the Nalco experts who have changed coagulation treatments from guess work to science.

because thorough coagulation traps a large percentage of microbiological organisms in the floc formation. As a result, waters need less bactericide treatment to meet requirements for low bacteria count.

Savings in Direct Chemical Costs

Chemical costs can be an important part of overall savings with Nalco high-performance coagulants and coagulant aids. The savings are significant in many plants. Two municipal plant superintendents report savings of $6,040* and $10,216* per year, respectively. A third plant reports that 1 ppm of Nalco 614 outperforms 10 ppm of alum*. In softening plants, chemical savings are often even greater, due to reduction in requirements for lime and soda ash, as well as coagulants.

**Itemized breakdowns of these savings are available on request. Also, there are probably similar figures on file for operating conditions closely parallel to your own.*

Savings with Expert Help

Nalco coagulation experts can cut the time and cost of setting up and proving out the coagulation chemicals and methods required to treat your water right. Nalco skills and experience in this field are unexcelled—and every Nalco Representative's basic products are water treatment results. Call him today, or write direct for Process Bulletin A1 . . . packed with facts and figures on coagulation in theory and practice.

NALCO CHEMICAL COMPANY

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W-K-M DIVISION

ACF INDUSTRIES

65

41

13

89

98

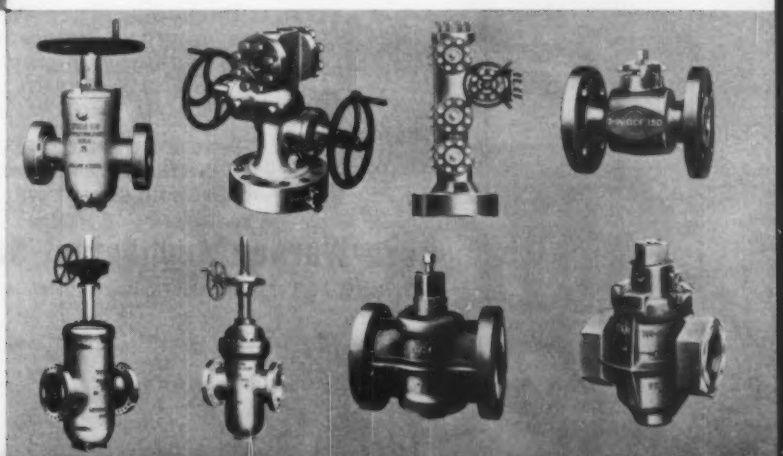
4

THE "SIGNATURES" OF MASTER CRAFTSMEN ARE ON EVERY W-K-M VALVE

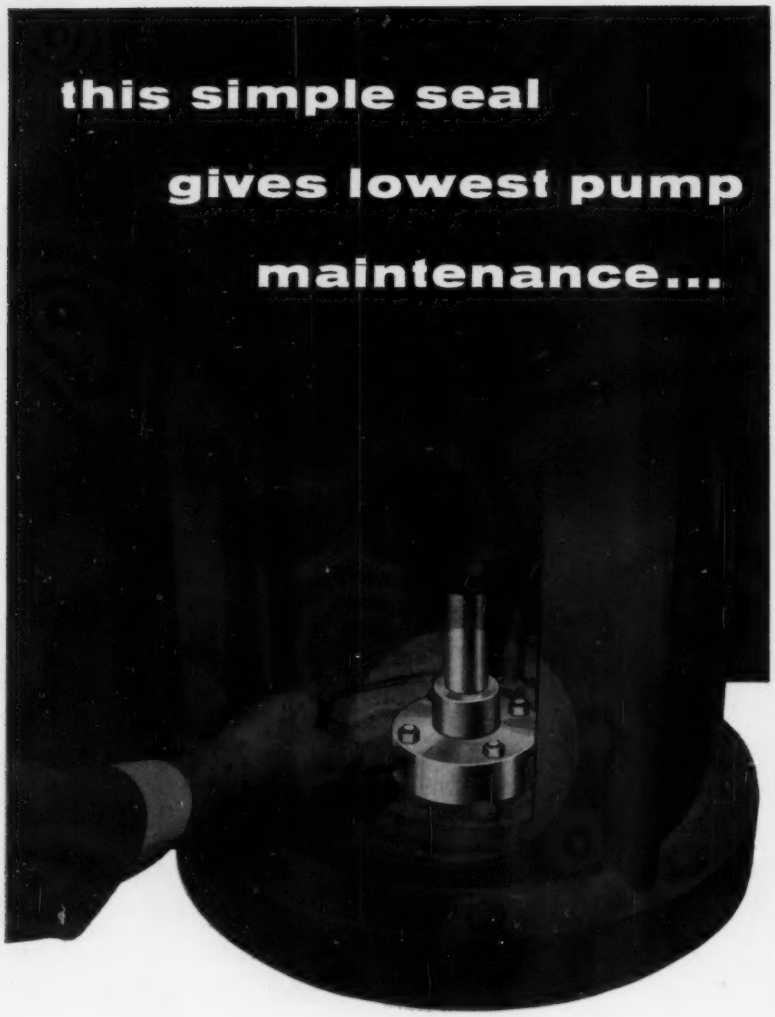
As your guarantee of the superior skill and workmanship that go into every W-K-M valve, each master craftsman stamps his personal emblem in the metal when he completes a part. The uniformly high quality of W-K-M workmanship is equalled by advanced engineering and methods of manufacture. Performance is the final measure of the value of a valve . . . when you install W-K-M you may be confident of satisfaction and long economical service.

When So Much Depends on a Valve

. . . *Specify* W-K-M



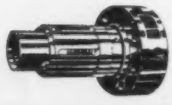
this simple seal gives lowest pump maintenance...

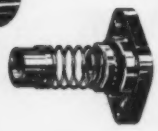


Save up to 66% of the time—expensive downtime—needed for installation or service of other mechanical seals used in plant process equipment.

The simple, effective Borg-Warner Type U Seal has no set screws—no close spring tension adjustments. It's fast and reliable.

For plants with a wide variety of pump service requirements, a minimum inventory of parts, and an easy change of gaskets adapts the Type U seal for service at temperatures of from —100 below zero to +650°F, and for pressures from 0 to 1000 psi.





Backed by Borg-Warner and proved in service, these dependable seals give complete safety, even in unattended stations.

Send for the latest Type U Seal engineering information —there's no obligation.

A PRODUCT OF B-W BORG-WARNER

Borg-Warner Mechanical Seals

P.O. Box 2017, Terminal Annex, Los Angeles 54, Calif.

Men . . .

ing Co.'s Baytown, Texas, refinery. Satterwhite also serves as an adviser and consultant to management on problems involving the refinery's water supply.

Thomas D. Durrance has been elected vice president public relations for Arabian American Oil Co. He succeeds **H. O. Thompson** who will serve the company in a consulting capacity.

Howard S. Bunn, vice chairman of the board, Union Carbide Corp., has been elected chairman of the board of directors, Manufacturing Chemists' Association. He succeeds **R. C. McCurdy** of Shell Chemical Co.

George T. Tobiasson has been named special assistant to **Col. J. C. Raaen,** vice president and general manager of research laboratories, Universal Oil Products Co. Tobiasson will handle coordination of testing activities at UOP.

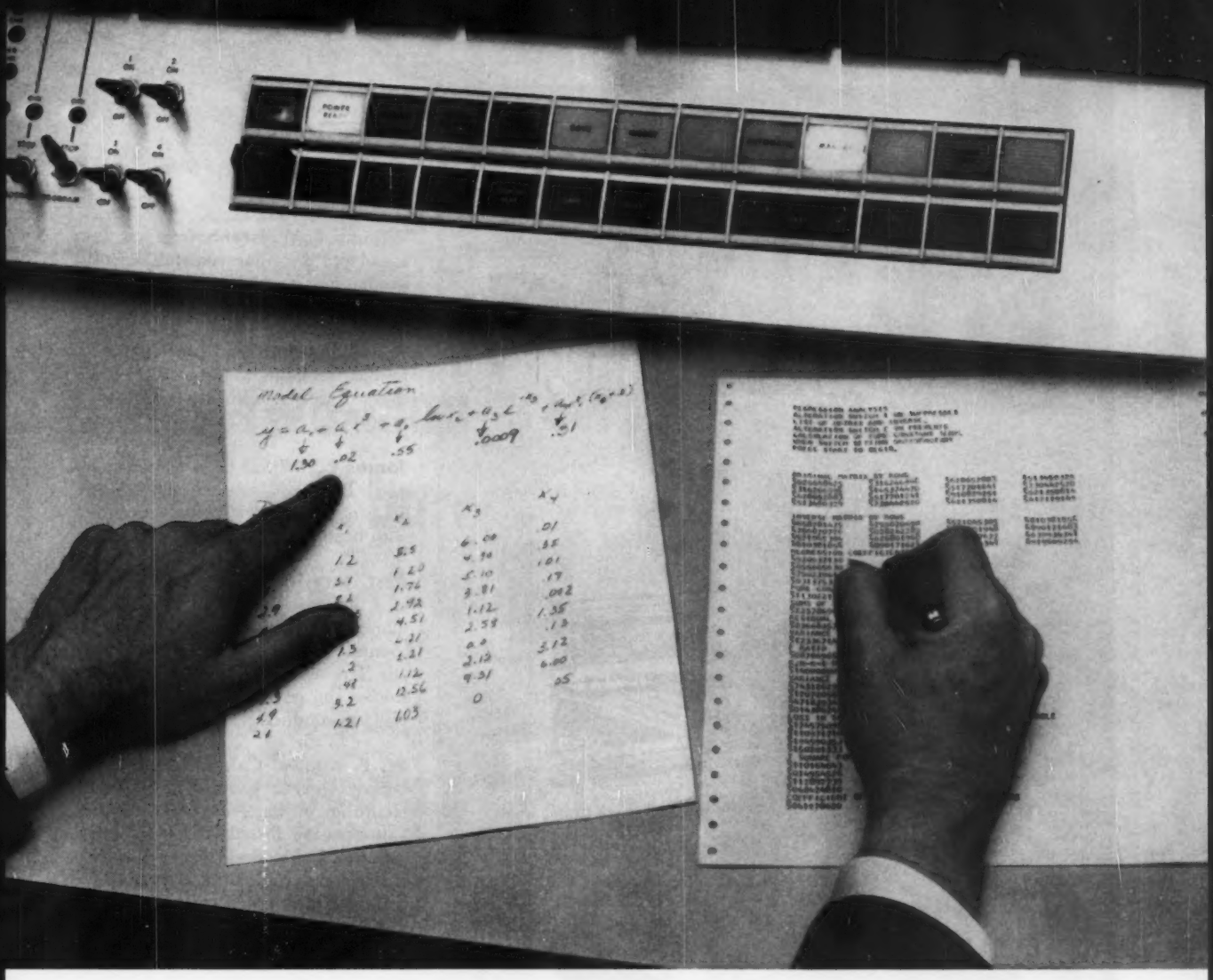
Hal W. Stewart, general counsel and a member of the board, The Ohio Oil Co., has retired after 39 years of service. **Clayton L. Orn** has been appointed general counsel and elected to the board to succeed Stewart.

Dr. Michael Rock has joined Olin Mathieson Chemical Corp. as a senior research chemist, Organics Division. He is located at the Olin Research Center, New Haven, Conn.

Jess C. Evans, Jr., Bartlesville, Okla., has been elected assistant treasurer of Cities Service Petroleum Co. Evans joined Cities Service in 1953.

Robert M. Wallace has been elected a vice president of Southwestern Engineering Co. of Los Angeles. Wallace will assist **Robert V. Gunther,** executive vice president and general manager of SWECO, in general administration and manufacturing.

Dr. Edward J. Gornowski has been named director, Petroleum Development Division, Esso Research and Engineering Co. **Donald D. McLaren** has been appointed assistant director of the division. **Charles W. Tyson** has been made special assistant to



Want to find the coefficients? It's easy with the new Regression Analysis program for the IBM 1620

Here's another program offered free-of-charge to users of the IBM 1620 Data Processing System. It gives you the kind of results you might expect only from a much more expensive computer. But users of the 1620 know that its low rental cost is deceptive. The 1620 packs *more computing power per cubic inch* than any other computer in its size range.

The Regression Analysis program is a good example. Suppose you want a fit for production purposes. If you employ more than two variables you probably have difficulty visualizing the representation of your data. If linearity is not the case, you must often guess blindly at a polynomial of high degree, accept or reject the fit with something approaching a sixth sense, and either try again or settle for the results you have.

The new Regression Analysis program lets you handle expressions containing up to *24 variables*. If you have the even more complicated task of handling many dependent variables, the program will generate regression coefficients with a maximum number of dependent variables not exceeding one-half the number of independent variables.

This program will also fit non-linear functions and hyper-surfaces. Compare this performance with that of any other computer in the 1620's price range.

A basic 1620 installation rents for just $1600 per month. For details, contact your local IBM Representative.

IBM's 1620 is a compact desk-size computer.

IBM®
DATA PROCESSING

Why switch?
KEY CHEMICALS
Key chemical transportation for caustic soda
Once by rail, always by rail? Not necessarily. Changes in tonnage, freight rates, or facilities for storage may make a switch to barge shipment of liquid caustic a wise move. This is something we check carefully—and often—for our customers. With our Wyandotte plant at the hub of the Great Lakes, and our Geismar plant near the mouth of the Mississippi—we are ideally situated to ship by barge, rail, or truck. Call us.
WYANDOTTE CHEMICALS
MICHIGAN ALKALI DIVISION, WYANDOTTE, MICHIGAN

Men . . .

the vice president, petroleum processes.

William E. Wolstenholme has been appointed a senior research scientist at the Research Center of United States Rubber Co., Wayne, N. J. Wolstenholme, a member of the Plastics Research Department, is working with problems relating to the physical properties of polymers to molecular structure.

James E. Iliff has been named manager, Process Division, The Austin Co., engineering and construction firm with headquarters in Cleveland, Ohio.

Asst. Interior Secretary Kelly has been appointed government co-chairman of the agenda and appointment committees, National Petroleum Council. The agenda committee considers studies the government requests the NPC to conduct.

W. F. Knode, Calgary, president of Grizzly Petroleum Co. and former chairman of the Alberta Oil & Gas Conservation Board, and **W. R. Persons,** St. Louis, president of Emerson Electric Co., have been elected to the board of directors, Plymouth Oil Co. Their memberships expand the board to nine members.

Dr. Charles E. McGinn has been appointed assistant director of research for Solvay Process Division, Allied Chemical Corp. Dr. McGinn joined Allied Chemical's National Aniline Division in 1941 as a chemist at the Buffalo Research and Development Laboratory.

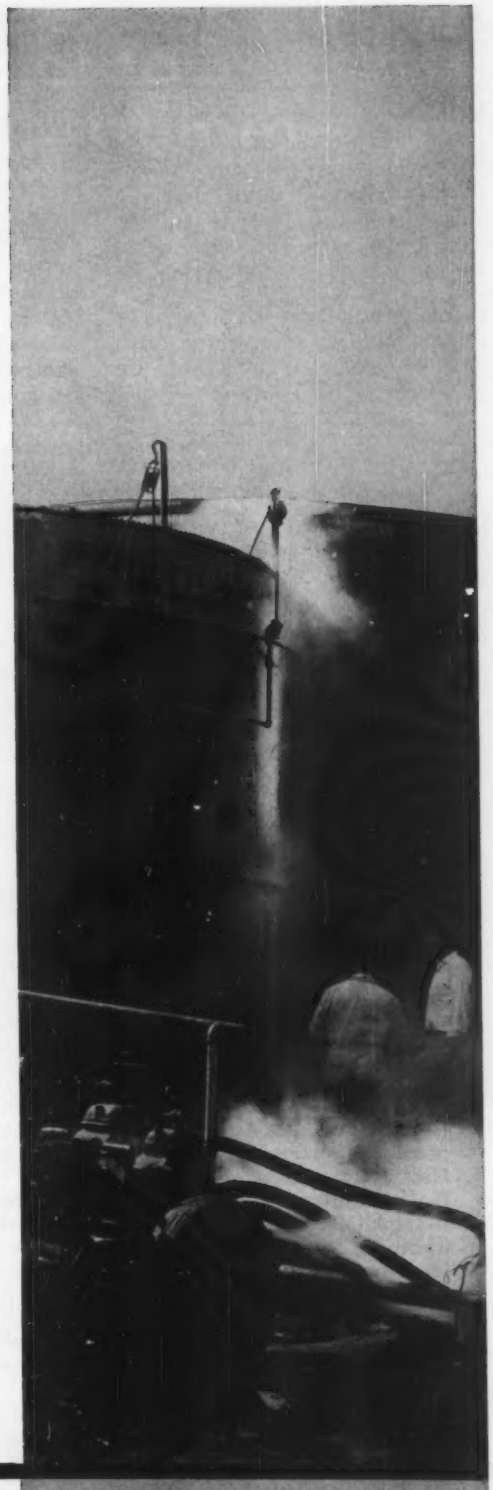
Michael B. Brewer has joined the Research and Development Department, American Oil Co., Whiting, Ind. He will investigate the economics of newly developed processes for refining petroleum.

David A. McCaulay has been appointed senior research associate, Research and Development Department, American Oil Co., Whiting, Ind. McCaulay joined the staff in 1944 as a research chemist, and in 1954 he was named research associate.

Jerald M. Honeycutt has joined Jefferson Chemical Co., Inc., as a

Oakite ECP
engineered cleaning program

helps two-man crew strip tank bare in matter of hours



Rust-spotted, oil-splotched and peeling, an oil storage tank cried out for repainting. But stripping the old paint and soil had previously taken many tedious—and costly—man-hours of wire brush work. When refinery called in the Oakite engineer, he drew up an ECP, including a recommendation to strip tanks by the Oakite Hot Flow-On method. A heated solution of Oakite Stripper M-3 was flowed onto the tank surface through a perforated pipe "rake," recovered in a canvas trough, and recirculated. In just a few hours a painting team had moved in and the two-man stripping crew was ready to tackle another unsightly tank.

WHAT IS OAKITE ECP? It's an *Engineered Cleaning Program* that stresses chemical cleaning. It's engineered specifically for your refinery, for your cleaning problems, and for each cleaning operation—tower by tower, valve by valve.

The Oakite engineer lends personal and experienced supervision to each phase of the program. He supplies detailed instruction based on practical knowledge of refinery cleaning needs. Each Oakite ECP is backed by a *laboratory* concentrating on chemical cleaning research, by *materials* known to make short work of refinery soils, by proved *methods*. Send for booklets. Oakite Products, Inc., 50B Rector Street, New York 6, N. Y.

OAKITE

over 50 years' leadership in industrial cleaning

Est. 1909 SCIENCE

Export Division Cable Address. Oakite

Technical Service Representatives in Principal Cities of U S and Canada

Oakite ECP

your economy key

For more data on advertised products, use cards, last page.

Men . . .

staff engineer. He will handle process analysis and optimization and application of systems engineering and operations research methods to company operations. He will also investigate electronic computer applications, including automatic process control. He will headquarter in Houston.

Dr. John N. Street has been elected vice president in charge of research, The Firestone Tire & Rubber Co. Dr. Street has been director of chemical laboratories for the past 12 years. He joined Firestone in 1926 as a research chemist and two years later was appointed assistant director of research.

H. T. Hamblen, who has been head of the Training and Communication Division in the southwest region, Humble Oil & Refining Co., has been appointed training coordinator in the personnel development section. **J. U. Parker,** formerly chief safety engineer in the southwest region, has been named chief safety engineer in the headquarters organization.

R. A. Randels, manager, Fire and Safety Department, Shell Oil Co.'s Wood River, Ill., refinery; **J. Howard Myers,** director of safety and fire prevention, The Atlantic Refining Co., Philadelphia; **Fred R. McLean,** manager, Safety and Claims Department, Mobile Oil Co.'s Detroit Division; and **Jack H. Brown,** superintendent of engineering and building maintenance, Tidewater Oil Co., New York, have been awarded certificates of appreciation by the American Petroleum Institute at its 14th annual midyear meeting of safety committees.

Robert F. Vickers has been named secretary, Vickers Petroleum Co., Inc., Wichita, Kan. He replaces **M. C. Lyons,** who has retired. **V. J. Lumm,** former assistant treasurer, has been appointed assistant secretary.

J. D. Winzenreid, assistant to the president, Canadian Husky Oil Co., and **E. J. Husemann,** treasurer of Husky Oil Co., have been elected vice presidents, Canadian Husky.

John G. Alexander has been appointed secretary of Olin Mathieson Chemical Corp. Alexander, who was formerly first assistant secretary, succeeds **Robert E. McCormick,** who has been named a consultant.

John O. Collins has been named a research associate, Products Research Division, Esso Research and Engineering Co. The post is awarded to scientists with outstanding technical ability.

F. T. Davies, vice president of Gulf European, has been elected senior vice president of the firm. Davies is also director of Gulf Oil (Great Britain) and Kuwait Oil Co.

Alfredo Federico Bracht, an Argentine business executive and financier, has been elected president of Petroquimica Argentina, S.A. (PASA). **Dr. Wesley S. Coe** has been named managing director of PASA. Dr. Coe is former director of research and development for Naugatuck Chemical Division, United States Rubber Co.

Vicente Valle, Amuay, Venezuela, has been appointed director of personnel relations for Refineria Panama, S.S. Formerly assistant industrial relations group head at Creole Petroleum Corp.'s 300,000-bpd Amuay re-

No, we're not talking about extra-sensory perception although it is a fascinating subject. Actually, we're inquiring as to your extended surface potential or, more simply, whether you are a possible user of Air Cooled Heat Exchangers.

If you are, you should pay particular attention to the above photograph. It graphically illustrates the *Metalbond* fin tube, an engineering feature which has contributed to the wide acceptance of SMITHCO Air Cooled Heat Exchangers by process engineers throughout the world. The *Metalbond* fin tube eliminates costly air gaps by providing an uninterrupted metallic thermal path for flow of heat from the inside of the tube to the outermost edge of the fin. SMITHCO *Metalbond* also protects against corrosion and has proven to be the most dependable bond between fin and tube yet devised.

When cooling problems arise, consult SMITHCO; you'll find SMITHCO Air Cooled Heat Exchangers are loaded with ESP — Extremely Satisfying Performance!

SMITHCO
ENGINEERING INC

P.O. BOX 7070 SOUTHSIDE STATION TULSA, OKLAHOMA

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Now it's much easier to solve your pipe motion problems

. . . with new Flexonics EXPANSION JOINT ENGINEERING GUIDE

New convenient way to solve pipe motion problems! Flexonics Expansion Joint Engineering Guide – just off the press – contains a wealth of vital information in easy-to-read, easy-to-use form. 42 pages of calculations, tables, anchoring and guiding data. Every piping system designer needs this new book. Mail the coupon for your FREE copy!

EJ-275

Flexonics

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FLEXIBLE METAL and SYNTHETIC HOSE EXPANSION JOINTS
BELLOWS • SPECIAL TUBULAR ASSEMBLIES

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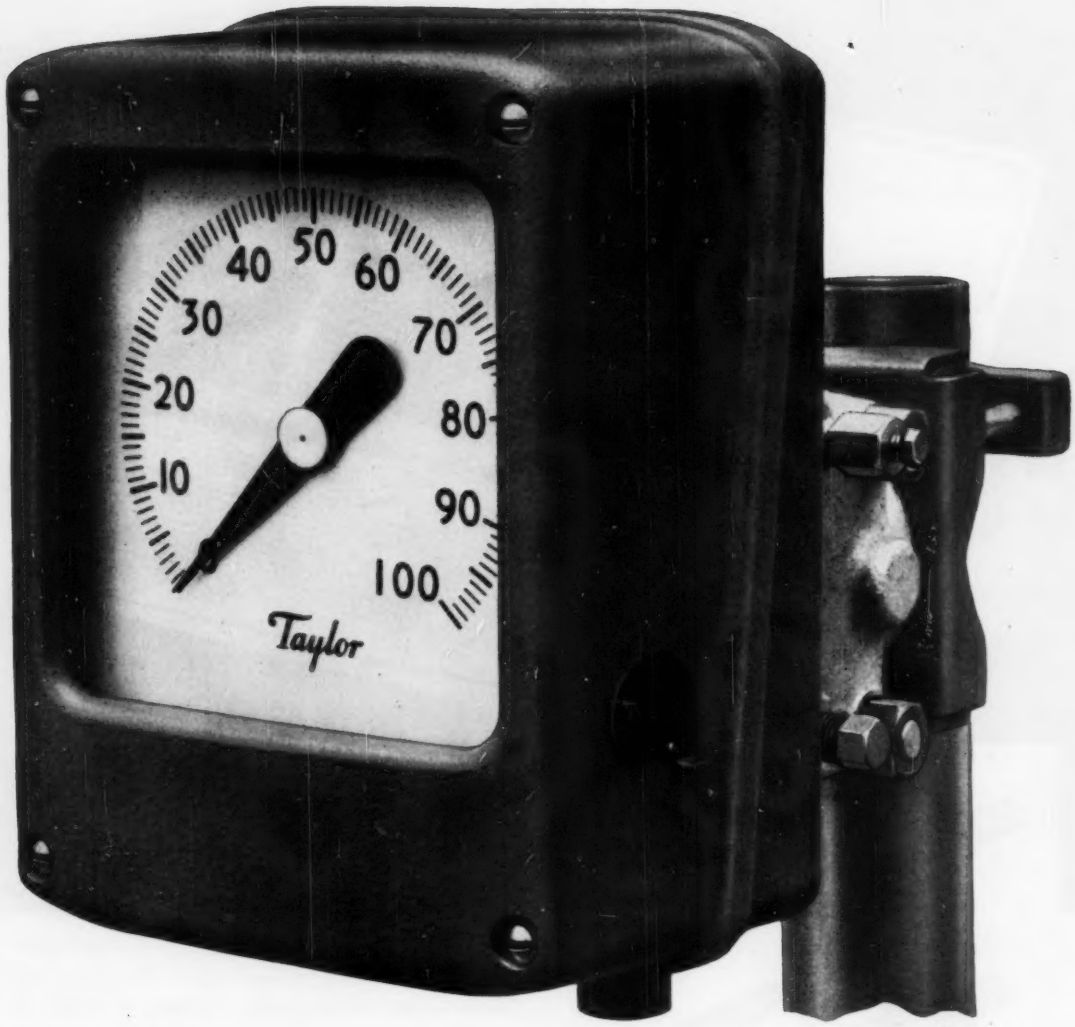
Please send my free copy of the new Flexonics Engineering Guide on Expansion Joints, Expansion Compensators, and Pipe Guides and Supports.

A DP TRANSMITTER



212T TRANSCOPE® Indicating Flow and DP Transmitter gives you all the features you expect from a truly fine DP Transmitter . . . and the only one that can be calibrated linear with flow as well as differential pressure without changing parts.

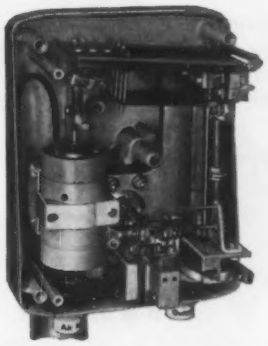
Taylor Instruments

OF MANY USES!

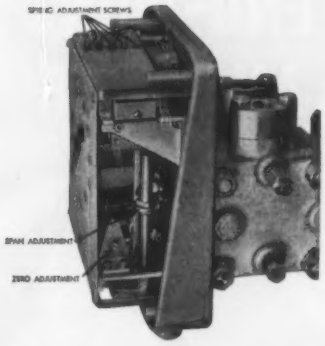
New Taylor 212T Transmitter is first and foremost a superior DP Transmitter...

Taylor's 212T TRANSCOPE® Transmitter is an outstanding example of "all this and heaven too". Basically it is a sound DP Transmitter, but when used for flow it can be calibrated to give a linear output without additional parts. It's available in indicating or non-indicating models. And with all its superior features *you pay no premium in price.*

Check the highlights listed here, then call your Taylor Field Engineer for a demonstration and write for **Bulletin 98413.** Taylor Instrument Companies, Rochester, N. Y., and Toronto, Ontario.



Open case design provides free access for maintenance.



Diagonally split case gives easy access for all adjustments.

Liquid-filled primary unit means:

Positive overrange protection. Hydraulic overrange protection to full body rating in *either* direction.

Isolation of internal parts. Working parts—except diaphragms themselves—are exposed only to non-corrosive silicone oil.

Built-in damping. Effective pulsation damping occurs at frequencies greater than approximately 2 cycles per second.

Exceptional rangeability.

Normal range span is 20 to 250" water. However, superior design and engineering quality permits over-calibration in either direction with good performance.

Mounting and connection versatility for any installation.

Process connections can be at top, at back or at bottom. ½" NPT fittings set on 2⅛" centers for convenience in piping directly to standard orifice flange taps. Universal mounting bracket can be secured to standard 2" horizontal or vertical pipe, or bolted to flat surface.

Good, clean mechanical design.

Diagonally split case makes all calibration adjustments easily accessible by simply removing cover. Zero adjustments can be made externally. Sturdy, protective case, designed for field locations.

PLUS

Servo power for square root extraction.

Produces an output directly proportional to flow or differential pressure . . . a cost-and time-saving feature when applied to computer control, or ratio and cascade control systems.

Servo power for indication accuracy.

Powerful servo relay drives tape movement to provide indication on a big 11¾" scale. It eliminates the necessity for externally mounted receiver gages.

Non-indicating model, showing rear mounting and bottom process connections.

MEAN ACCURACY FIRST

Men . . .

finery in Venezuela, he will make his new headquarters in Colon, Panama.

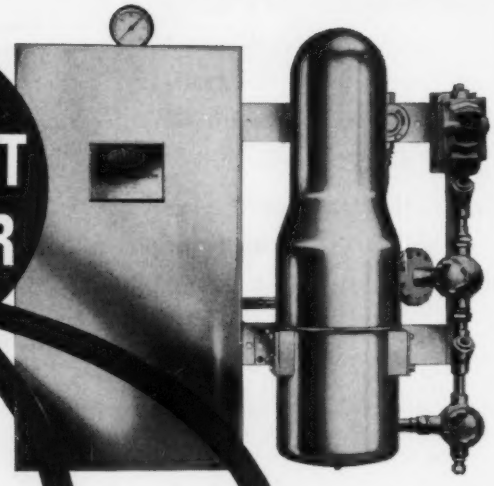
Dr. Howard Rase, associate professor of chemical engineering, The University of Texas, has been named winner of the $1,200 Convair award. The award is given annually for effectiveness in engineering teaching at The University of Texas.

Edward Littlejohn has been made manager of Humble Oil & Refining Co.'s Headquarters Public Relations Department. Littlejohn has been assistant manager of public relations for Standard Oil Co. (New Jersey).

A. G. Treadgold, vice president, manufacturing, United Carbon Co., Houston, has been elected treasurer of the company. Treadgold succeeds **T. A. Whelan,** one of the co-founders of United Carbon in 1925, and the company's first treasurer. Treadgold, who also has been with United since it was founded, continues as vice president in charge of manufacturing.

now on-stream

TOTCO END-POINT ANALYZER



optimum returns through quality control

Among companies now using one or more Analyzers for monitoring or controlling are:

The Atlantic Refining Company	Standard Oil Company of Calif.	Texas City Refining, Inc.
Gulf Oil Corporation	The Standard Oil Company of Ohio	Tidewater Oil Company
Mobil Oil Company	Sun Oil Company	Wilshire Oil Company of California
Richfield Oil Corporation	Texaco, Inc.	and many other leading firms.

Applications include quality control of reformer feed, gasoline and distillate components, and "special" products.

Permits closer control to end-point specifications and increased yield. Continuous analysis improves quality. Write for Bulletin 6000-11.

Totco also makes an Initial Boiling Point Analyzer. Write for Bulletin 1259-11.

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TOTCO

TECHNICAL OIL TOOL CORPORATION
1057 North La Brea Avenue
Los Angeles 38, California • OLdfield 4-1763

Gulf Coast Representatives: The Mott Co., 1719 McKinney, Houston 1, Texas • *East Coast Representatives:* Energy Control Co., Inc., 5 Beekman Street, New York 38, New York — Energy Control Corporation, 3147 North Broad Street, Philadelphia 32, Pennsylvania.

Dr. Louis J. Croce has been promoted to manager, Petro-Tex Research Department, Food Machinery and Chemical Corp.'s Chemical Research and Development Center, Princeton, N. J. He will be in charge of all research activities for Petro-Tex at the center.

Jerome Green has joined the Research and Development Department, American Oil Co., at Whiting, Ind., as a senior project chemist. He will carry out research on problems in the corrosion of metals.

Captain Matthew V. Carson, Jr., former adminstrator of the mandatory oil import program, Washington, D. C., has joined the executive staff, Sinclair Oil Corp. Carson will spend several months in various headquarters of Sinclair Oil's subsidiaries throughout the country before permanent assignment.

Arthur C. MacLeod has joined Union Carbide Chemicals Co. as special assistant to the manager, Business Planning and Aanalysis Department. MacLeod has been with Union Carbide Corp. since 1952. He was formerly a staff engineer, Union Carbide Olefins Co., working on engineering design and economic evaluation work.

Ralph E. Meints, a partner in the Chicago engineering firm of Vern E. Alden Co., has joined the engineering staff of Leonard Construction Co., Chicago. He will work on special engineering and development assignments for Leonard.

W. H. Salzenberg, general manager, Polychemicals Department, E. I. du Pont de Nemours & Co., Wilmington, Del., and **T. T. Miller,** president, W. R. Grace & Co., Polymer Chemicals Division, have been named chairman and vice chairman respectively, plastics committee, Manufacturing Chemists' Association.

Thomas S. Gates has been elected to the board of directors, Cities Service Co. Gates is chairman of the Executive committee of Morgan Guaranty Trust Co. New York.

Charles H. Culnane, Jr., has been appointed assistant operating superintendent in charge of SunOlin Chemical Co.'s ethylene and ethylene oxide plants now under construction at

Babbitt *Adjustable* **SPROCKET RIM**
with Chain Guide
CHANGES THAT DANGER ZONE TO A SAFETY ZONE

. . . cuts costs when you SIMPLIFY PIPE LAYOUT

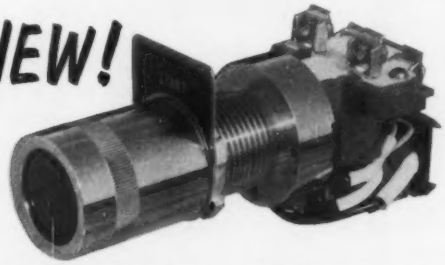
When you modernize to make money, go all the way. Cut piping costs to minimum with planned simplification. Give your staff a free hand to effect economics—at the same time, convert Danger Zones to Safety Zones. Equip every overhead valve wheel in your plant with Babbitt Adjustable Sprocket Rims with Chain Guides.

- They simplify pipe layout.
- They fit any size valve wheel.
- They are easy to install and operate.
- They operate any valve from the floor.
- They save time and money.
- The first cost is the only cost (no maintenance).
- They are packed completely assembled (one to a carton), with easy-to-follow instructions.
- A hot-galvanized rust proof chain is available for all sizes.

Babbitt Adjustable Sprocket Rims with Chain Guide are carried in stock by most mill supply houses. Just phone your mill supply salesman, or contact us direct.

Babbitt STEAM SPECIALTY CO.
6 BABBITT SQUARE, NEW BEDFORD, MASS., U.S.A.

NEW!



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LIGHTED PUSHBUTTON STATION
Half the Space—Twice the Convenience

USE IT { AS A COMBINATION PUSHBUTTON-PILOT LIGHT
AS A PUSH-TO-TEST PILOT LIGHT

- All Standard Colors
- 110v., 220v., or 440v.
- 4 11/16" Overall Length

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NELSON *Electric* MANUFACTURING CO.
TULSA, OKLAHOMA
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Genuine RIDGID

At Your Supply House!
The Ridge Tool Company, Elyria, Ohio, U.S.A.

AIR TOOLS

to cut your maintenance costs

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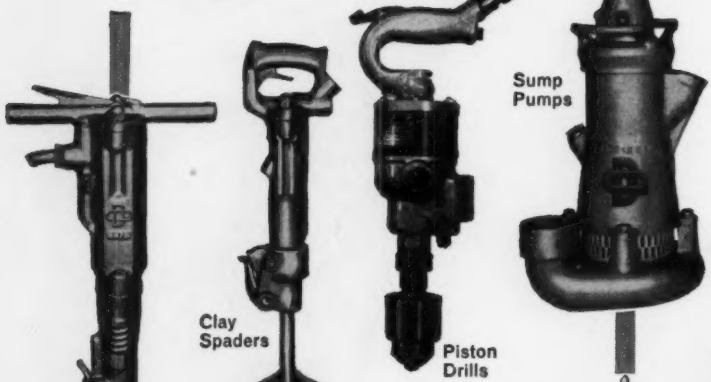
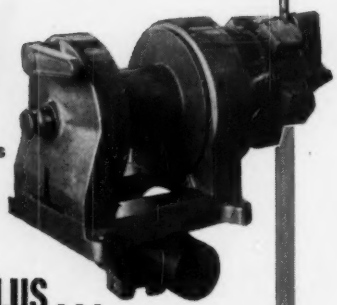


Sump Pumps

Clay Spaders

Piston Drills

Paving Breakers



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Backfill Tampers

Model RP125
Portable Air Compressor

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concrete vibrators, utility drills, grinders, scalers, and other handy air-powered tools. See your Gardner-Denver air tool specialist or write for information.

Air power-where you need it...

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Men . . .

Claymont, Del. Prior to joining Sun-Olin, Culnane was with Wyandotte Chemicals Corp. for nine years where he was superintendent of its glycol plant. Earlier he was with Texaco, Inc., as a chemical engineer for seven years.

Wilton F. Espenscheid, a research chemist in Socony Mobil Oil Co.'s Research Department since 1958, has been named this year's winner of the company's incentive fellowship award at its Paulsboro, N. J., laboratory. The award was established in 1947 to enable laboratory employes with outstanding ability in science to further their academic training.

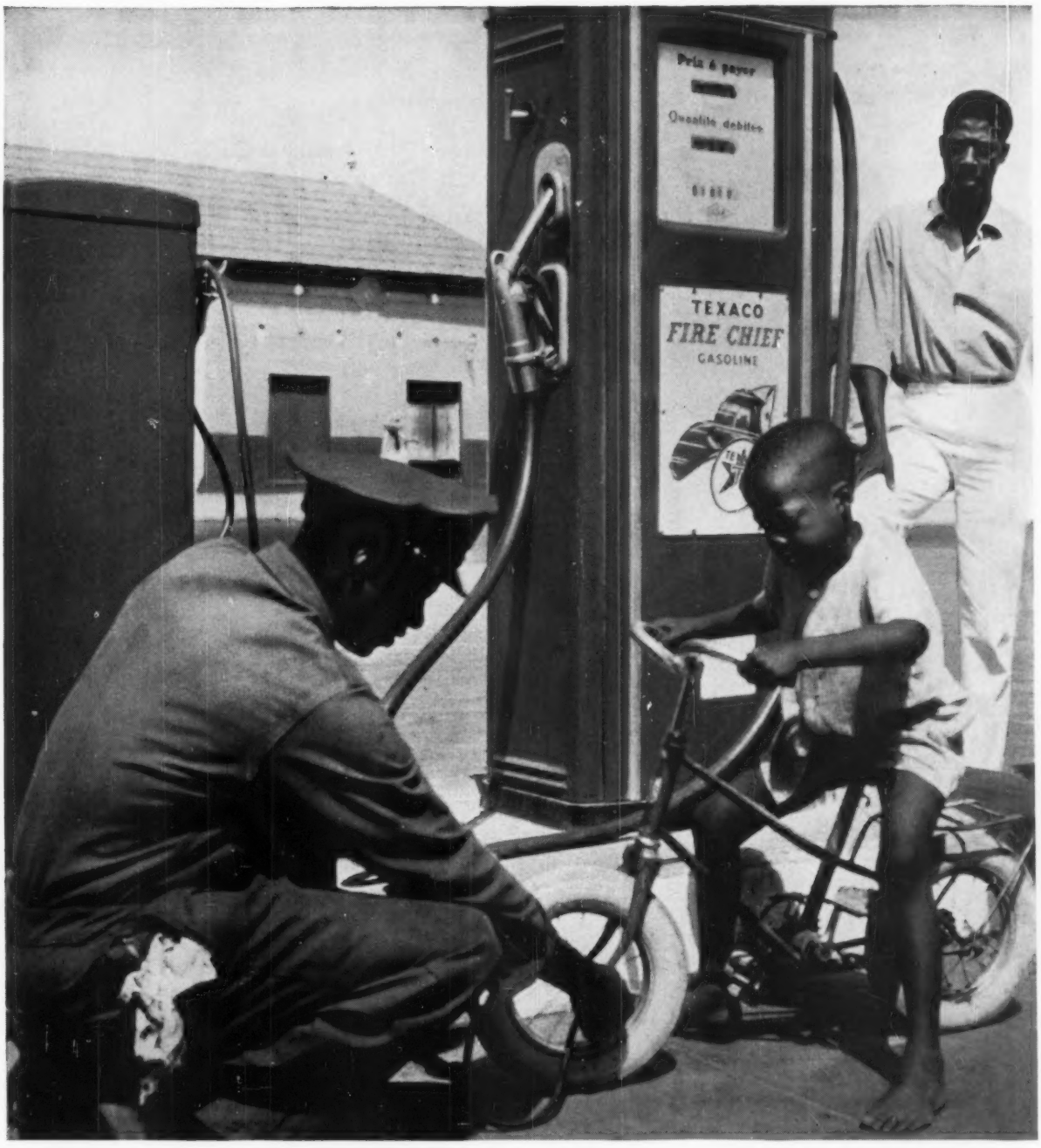
W. Wilson Bond has been promoted to chief engineer in charge of the estimating section, American Oil Co.'s General Engineering Department at Whiting, Ind. The section prepares cost estimates, issues engineering requisitions and does evaluation work on projects required for the company's 12 refineries. Bond replaces **Clovis E. Dyckman,** who has retired. Bond started with American Oil in 1945. He received a bachelor of science degree in chemical engineering in 1941 from the University of Tennessee.

Bond

Robert L. Mitchell has been elected a vice president, Celanese International Corp. Since June 1960, he had been a vice president, planning, and for three years previously, had been director of technical and economic evaluation. He joined Celanese in 1947 as a chemical engineer at Corpus Christi, Texas.

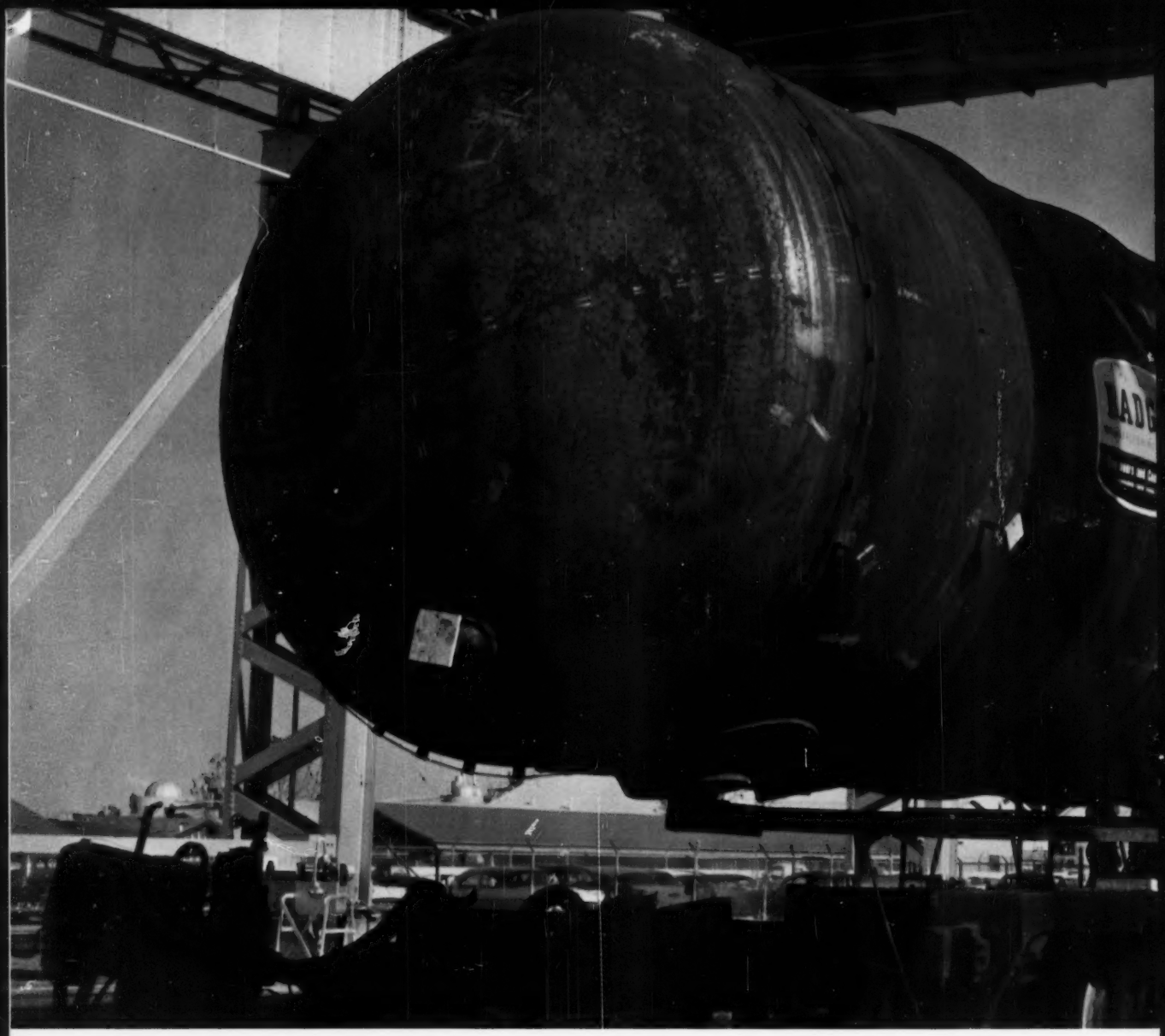
Dr. Henry B. Hass has been appointed director of chemical research, The M. W. Kellogg Co., New York. Dr. Hass will direct the exploratory and research groups of the company.

Carl F. Vander Clute, 60, general manager, Marine Department, Gulf Oil Corp., died June 1 at his home in New York after a long illness.



Texaco in Dakar, West Africa, is an investment in progress—and in people. The man with the air hose is busy with a "customer". He is D. Magatte, a Texaco Dealer proud of his reputation of giving the best service in town. And Texaco is proud and fortunate to have men like D. Magatte representing them in many parts of the world. Texaco's own progress is built on helping others to develop new skills and personal security. As a major producer, refiner and marketer of oil, Texaco is contributing to the economic stability and to the growth of countries throughout the Free World.

TEXACO: SYMBOL OF WORLD-WIDE PROGRESS THROUGH PETROLEUM



This big fabrication is no tall story

It took six flat cars to ship this giant out of American Bridge's Orange, Texas, plate shop. Over 220′ long and more than 12′ in diameter, this tower is made from 33 steel rings, formed from $1\frac{3}{16}$-inch plates. High capacity boom-mounted electric welders joined the 33 rings, and special x-ray equipment checked the weld seams. ☐ What did we do for an encore? We fabricated three more towers, all about the same size—and weighing over 200 tons each. ☐ Badger Manufacturing Company, Engineers and Constructors, designed and erected the towers for a styrene manufacturing plant* now under construction for Sinclair-Koppers Chemical Company. ☐ King-size, custom fabrication is routine at American Bridge's Orange plate shop. Staffed by experienced experts, completely equipped with modern fabricating facilities,

This mark tells you a product is made of modern, dependable Steel.

cleared for all major tank and pressure vessel code work, and strategically located for rail, truck and water shipment; you can rely on precise, prompt and economical service on practically all plate work at American Bridge. ☐ Contact the nearest American Bridge contracting office and see how our services can work for you.

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*Process Licensor: Cosden Petroleum Corporation

General Offices: 525 William Penn Place, Pittsburgh, Pa. • Contracting Offices in: Ambridge • Atlanta • Baltimore • Birmingham • Boston • Chicago • Cincinnati Cleveland • Dallas • Denver • Detroit • Elmira • Gary • Harrisburg, Pa. • Houston • Los Angeles • Memphis • Minneapolis • New York Orange, Texas • Philadelphia • Pittsburgh • Portland, Ore. • Roanoke • St. Louis • San Francisco • Trenton • United States Steel Export Company, New York

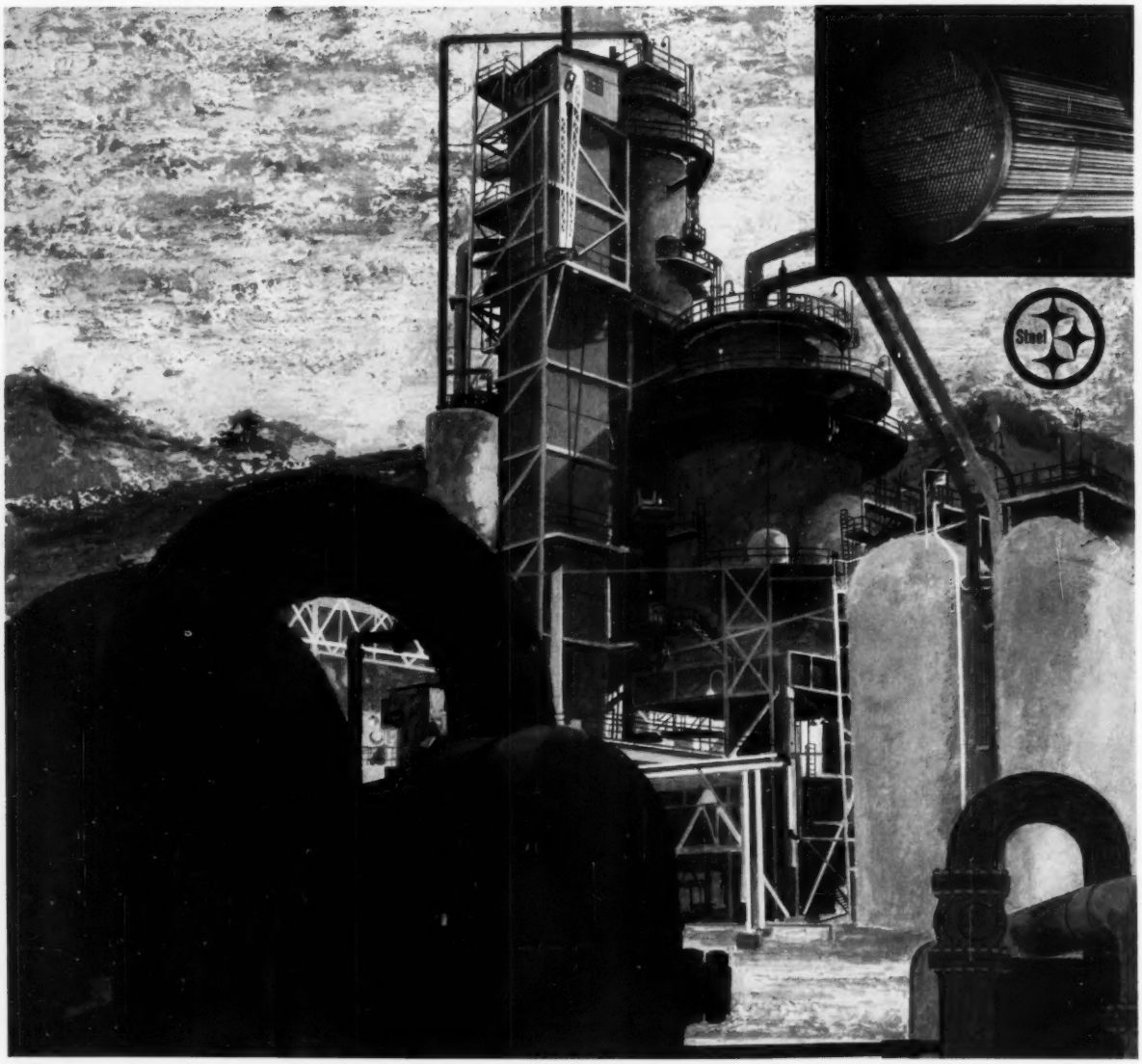
American Bridge Division of United States Steel

USS

Find the Refineries' Invisible Workers!

It's welded steel heat exchanger tubing by The Standard Tube Company

Tubing that is easy to roll-in, bend, expand or flare . . . that's our specialty. We have the production facilities . . . the tube industry's most modern plant! We have the testing facilities . . . hydrostatic and eddy current to surpass specifications. We have the personnel . . . most of our "tubemen" have been with us for years. And Standard tubing is available throughout the country. It all adds up to lower cost, higher quality and better service when you buy Standard welded tubing. For further information on our steel and stainless steel products and capabilities, write for brochure No. 6.



THE STANDARD TUBE CO.

Over 40 years specializing in Quality Welded Tubing

DETROIT 39, MICHIGAN

What's Happening

Continued from Page 43

Imports control

There will be no changes in the mandatory oil import program from July-December, says Secretary of the Interior Udall. The only exception would be adjustments in allocations due to normal changes in import levels. Mr. Udall claims he "is not indicating at this time that there won't be changes" at a future date. He added that "industry was entitled to some assurance of the period just ahead."

Taxes stunt growth

The Administration's plans for taxing undistributed profits of foreign subsidiaries of U.S. companies has chemical industry plenty upset. The concensus: President Kennedy's ideas could stunt industry's growth here and abroad. They could also destroy past progress in making international tax systems compatible, and would violate agreements already made.

Manufacturing Chemist's Association summed it up this way for House Ways and Means Committee: Plan will inhibit foreign-trade growth of U.S., making it almost impossible to solve "balance of payments" question . . . It will impair domestic investment, and weaken the economic progress and unity of free world . . . President's charge that foreign subsidiaries enjoy a tax deferral privilege is false. It's universally accepted that a subsidiary's earnings should be taxed only when they become income to the parent. No other country has any other system . . . Plant construction and expansion abroad has not been based on tax advantages, but to maintain and expand markets in foreign countries where competition or government restrictions are strong.

Fines in price case

Fines up to $50,000 have been assessed against 11 of 12 oil companies convicted last December of conspiracy to fix retail gasoline prices in the South Bend-Mishawaka, Ind., area in 1957. The Federal court freed the twelfth defendent, Gulf Oil, by granting its motion for acquittal. Fines of $50,000 each were assessed against Standard of Indiana and Central West Oil, which the court called "the prime movers in the conspiracy." Lesser fines were assessed against Ohio Oil, Phillips, Cities Service, Texaco, Shell, Mobil, Hudson, Tornado and Pacer. Indiana Standard, Texaco and Ohio will appeal.

NLRB & professionals

The National Society of Professional Engineers has told House Labor Subcommittee that policy of National Labor Relations Board, which denies professional employes a separate decertification election from a mixed unit, is not consistent with Congressional intent of Taft-Hartley Act. Paul H. Robbins, executive director of NSPE, told Subcomittee that for seven years after passage of Taft-Hartley Act in 1947, NLRB allowed professional employes in a mixed unit to petition for separate election of their collective bargaining representatives. But, in 1955, he said, the Board reversed itself. It has since maintained that professional employes are not entitled to a separate vote regarding decertification of a bargaining agent if they are represented in a heterogeneous unit with nonprofessional employes.

Du Pont must sell

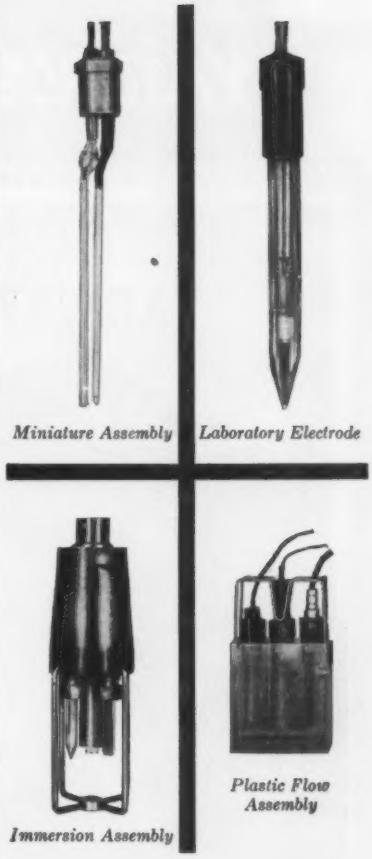
A 12-year antitrust fight between the U.S. Department of Justice and Du Pont comes to screeching halt with Supreme Court's decision that Du Pont must sell all its General Motors stock. The 63 million shares that Du Pont holds must be disposed of within 10 years. Market analyzers believe this 10-year period will "soften" impact on American stock market, since Du Pont has almost $3 billion in GM securities.

Even with this long time limit, however, it is expected the stock market will not be able to absorb all the shares without considerable drop in their value. Because of this evident cut in market price, Du Pont will probably want to dispense with many of the shares among a large number of its stockholders, as dividends.

National fuels study

The national fuels study issue is being waged hot and heavy via hearings before Senate Interior Committee. Here are some issues as seen by Senators attending:

Pastore (D.-R.I.): "We should not



To measure pH precisely start with L&N Electrodes!

Widely used both in laboratories and on process lines, L&N Electrodes have earned universal recognition for dependable, precise measurements of pH and redox.

Only L&N's specially developed glass composition provides minimum solubility to extend electrode life . . . minimum sodium error, to broaden the detection range.

If you're looking for a quality line of electrodes, ask for our informative Data Sheets: E-95(1) describing laboratory electrodes and NS5(1) describing industrial electrodes and mountings. Write Leeds & Northrup, 4923 Stenton Ave., Phila. 44, Pa.

LEEDS Instruments NORTHRUP Automatic Controls • Furnaces

Pioneers in Precision

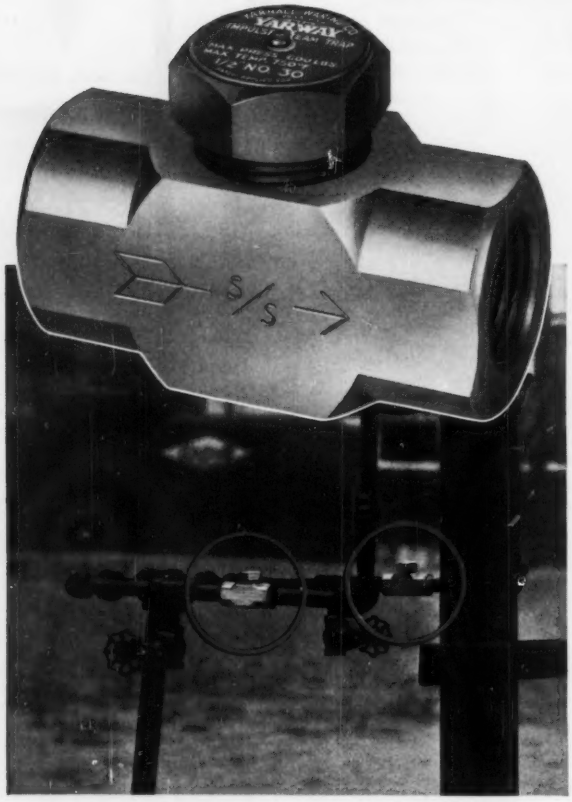
For more data on advertised products, use cards, last page.

YARWAY news briefs

from **Yarnall-Waring Company,** *Philadelphia 18, Pa.*

BRANCH OFFICES IN 19 UNITED STATES CITIES • SALES REPRESENTATIVES THROUGHOUT THE WORLD
STEAM TRAPS STOCKED AND SOLD BY 270 LOCAL INDUSTRIAL DISTRIBUTORS

YARWAY SERIES 30 IS THE STEAM TRAP FOR PEAK EFFICIENCY



Two Yarway Series 30 traps on tracer lines from a loading station to polystyrene storage tank at the Midland Division of The Dow Chemical Co., Midland, Mich. Steam pressure is 150 pounds.

on tracer lines, main drips, meter boxes and other steam equipment

Yarway Series 30 Impulse Steam Trap has won enthusiastic acceptance and scored outstanding success on those hundreds of applications where condensate is handled in moderate amounts. Here's why:

- Economy of operation, with closer condensate control
- Longer service life, with lever action reducing impact on valve seat
- Lower maintenance, with easily and quickly replaceable seat and disc
- High quality, all stainless steel—combined with a new low cost

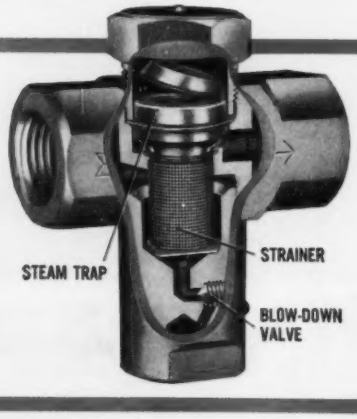
Here are a few typical user experiences:

TEXAS REFINERY—*Been using ½" No. 30's on drip legs to steam lines for 6 months. "No troubles whatsoever."*

PENNSYLVANIA TIRE MFR.—*Gradually replacing all traps on tire molds with Yarway No. 30's. "Amazed at their performance."*

MISSOURI STEEL PLANT—*Tested Yarway No. 30's against competitive traps, with result "Yarway No. 30 now standard on all main steam header drips."*

So it goes in plant after plant. Why don't *you* try Yarway Series 30 Traps? Available in ⅜" or ½" size; pressures 8 to 600 psi. Your nearby Industrial Distributor carries them. Write for his name.



NEW! COMPACT COMBINATION

NEW SERIES 130 steam trap combines a Series 30 trap, a strainer, and blow-down valve *all in one compact unit*—with these advantages:

- Saves space
- Saves installation costs
- Saves weight
- Saves on maintenance

Stainless steel construction, good for all pressures 8 to 600 psi.

Your Yarway distributor has SERIES 130 traps. Try one today—or write for new Bulletin T-1743-B.

For more data on advertised products, use cards, last page.

Happenings . . .

. . . encourage the carving out of portions of the total energy market for various competing fuels industry . . . Let's not suffocate residual oil and force people back to coal."

Engle (D.-Calif.): "Southern California is a fuels drought area . . . The answer isn't more oil or gas, or transportation of coal, or new hydro projects in the Northwest. We need all those things, but on an integrated basis and with a long look at the future and at conservation."

Randolph (D.-W. Va.): "I seek a thoroughly impartial and objective study of the whole fuels field, one that emphasizes the national concept of the fuels and energy problem."

Jackson (D.-Wash.): "What really motivates this study is the problem of the coal industry . . . We're going on a wild goose chase if we pursue in great detail all forms of energy."

- Changing Times -

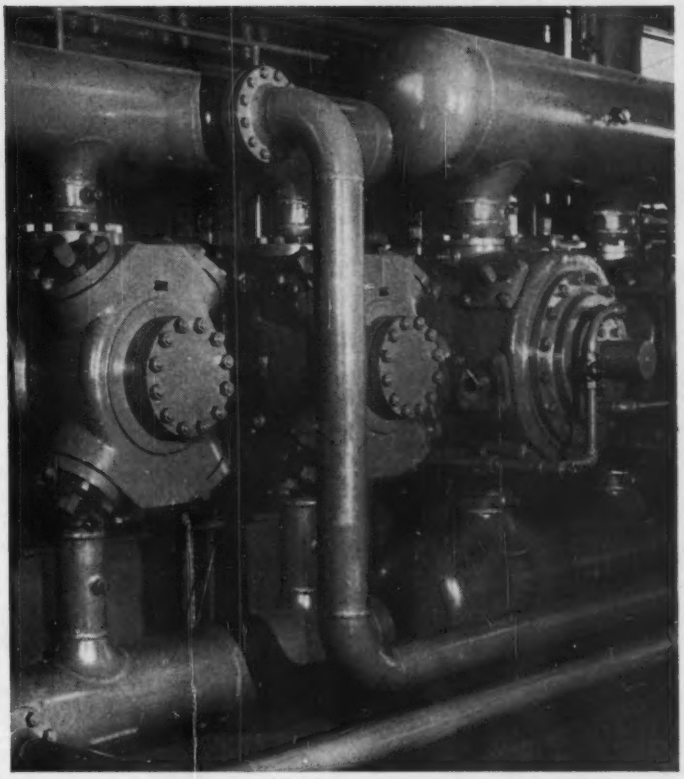
The Ralph M. Parsons Co., Los Angeles, buys Anaconda-Jurden Associates, Inc., engineering and industrial design subsidiary of Anaconda Co. in New York City. The Parsons-Jurden team will enlarge its work in petroleum refinery and petrochemical plant engineering and construction.

Bureau of Mines' revised estimate of domestic demand for all oils in 1961 is up 1.8 percent, or 9,848,000 bpd from 1960. Bureau reports say new supply is expected to be 2.1 percent higher than last year, with domestic production rising 2.0 percent and imports 2.5 percent.

Refinery runs, which averaged over 8-million bpd during May, might result in a product glut requiring runs to be cut, according to IPAA. Forecasts from IPAA disclose that third quarter demand should average 9.38 million bpd, about 2.7 percent above same period last year.

Interstate Oil Compact Commission reiterates its stand that imports of petroleum and petroleum products should be limited so that they only supplement domestic production instead of supplanting it. The IOCC points out that if the import program does not supplement production, oil conservation in the U.S. will fail.

PACKAGED
COMPRESSOR PIPING...



another example of

BONNEY SWEEPOLETS®

for sophisticated piping systems

Designed to eliminate all notch effects, the Bonney Sweepolet provides optimum stress distribution for critical piping systems such as the compressor bottles shown above on Worthington SLHC-10 gas engine angle compressors rated at 950 BHP each. These units were fabricated by Worthington-Lockett using Bonney Sweepolets for branch construction. Specify and use Bonney Sweepolets in your critical piping systems.

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also exclusive manufacturers of
WELDOLETS®
THREDOLETS®
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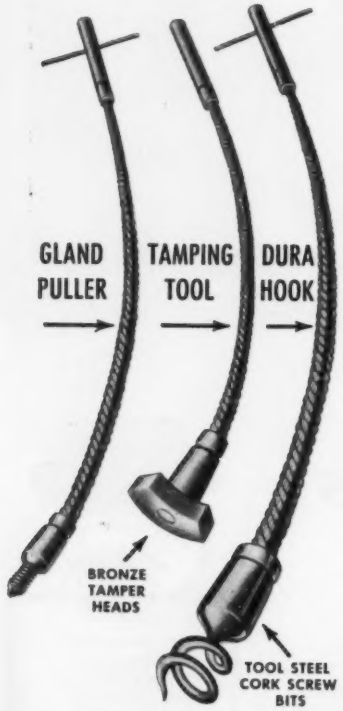
• • • • • • • • • • • •
CARBON STEEL
STAINLESS
ALLOY
for all services

BONNEY FORGE AND TOOL WORKS
ALLENTOWN, PENNSYLVANIA

DURA FLEXIBLE STEEL CABLE SHAFT PACKING TOOLS

Save time and bother removing and installing packing by using these flexible shaft hand tools. They perform perfectly in those "hard-to-get-at" places.



Write for illustrated Bulletin No. 314-PR covering sets, sizes and prices

The PERFECT SEAL TRADE MARK

DURAMETALLIC CORPORATION
KALAMAZOO, MICHIGAN

Meetings Calendar

July

18-20.....**Western Plant Maintenance and Engineering Show,** Pan Pacific Auditorium, Los Angeles, Calif.

August

14-17.....**Society of Automotive Engineers,** National West Coast Meeting, Sheraton Hotel, Portland, Ore.

28-Sept. 1.....**American Society of Mechanical Engineers,** International Heat Transfer Conference, University of Colorado, Boulder, Colo.

September

3- 8.....**American Chemical Society,** Fall Meeting, Chicago, Ill.

5- 8.....**ACS,** National Chemical Exposition, Chicago Amphitheater, Chicago, Ill.

11-15.....**Instrument Society of America,** Fall Instrument-Automation Conference, & Exhibit, Biltmore Hotel, Memorial Sports Arena, Los Angeles, Calif.

-14.....**Natural Gasoline Association of America,** Rocky Mountain Regional Meet, Northern Hotel, Billings, Mont.

14-15.....**ASME, AIEE,** Engineering Management Conference, The Roosevelt Hotel, New York City.

20-21.....**Western Petroleum Refiners Association,** Rocky Mountain Regional Technical-Industrial Relations Meeting, Henning Hotel, Casper, Wyo.

24-27.....**ASME,** Petroleum Mechanical Engineering Conference, Hotel Muehlebach, Kansas City, Mo.

24-27.....**American Institute of Chemical Engineers,** National Meeting, Lake Placid Club, Lake Placid, N.Y.

25-28.....**American Welding Society,** Fall Meeting, Adolphus Hotel, Dallas, Texas.

October

4- 6.....**ASME, Process Industries Conference,** Shamrock Hilton Hotel, Houston, Texas.

11-12.....**WPRA,** Waste Disposal and Stream Pollution Conference. Hotel Lassen, Wichita, Kan.

12-13.....**California Natural Gasoline Association,** Annual Fall Meeting, Lafayette Hotel, Long Beach, Calif.

23-26.....**National Association of Corrosion Engineers,** South Central Region Conference and Exhibition, Shamrock Hilton Hotel, Houston, Texas.

25-26.....**WPRA,** Annual Question and Answer Session on Refining Technology, Rufus Garrett Hotel, El Dorado, Ark.

-27.....**NGAA,** Southern Regional Meeting, Carlton Hotel, Tyler, Texas.

29-Nov. 1.....**National Lubricating Grease Institute,** Annual Meeting, Rice Hotel, Houston, Texas.

November

9-10.....**SAE,** National Fuels & Lubricants Meeting, Shamrock Hilton Hotel, Houston, Texas.

13-15.....**American Petroleum Institute,** Annual Meeting, Conrad Hilton Hotel, Chicago, Ill.

-17.....**NGAA,** Panhandle Plains Regional Meeting, Herring Hotel, Amarillo, Texas.

26-Dec. 1.....**ASME,** Winter Annual Meeting, Statler Hilton Hotel, New York, N. Y.

27-Dec. 1.....**Exposition of Chemical Industries,** New York Coliseum, New York, N. Y.

December

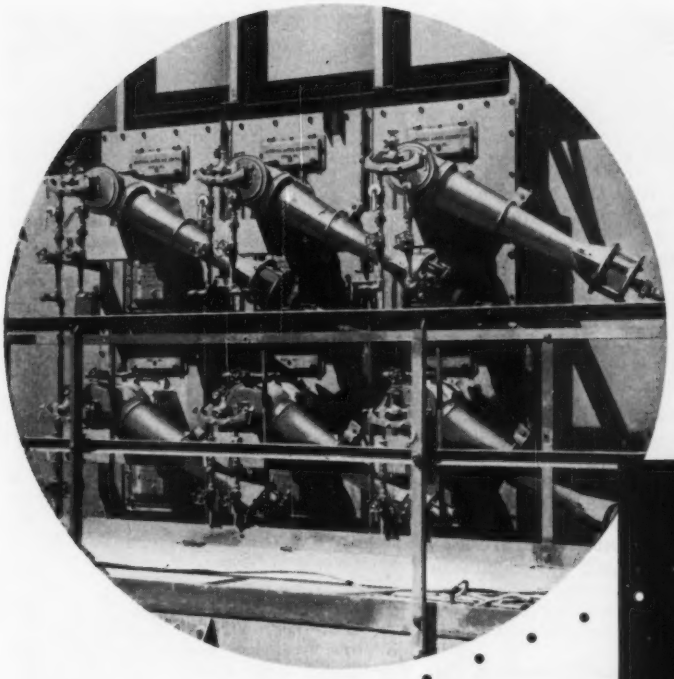
3- 6.....**AIChE,** Annual Meeting, Hotel Commodore, New York, N.Y.

5- 6.....**WPRA,** Computer Conference for Refiners, Hotel Tulsa, Tulsa, Okla.

1962

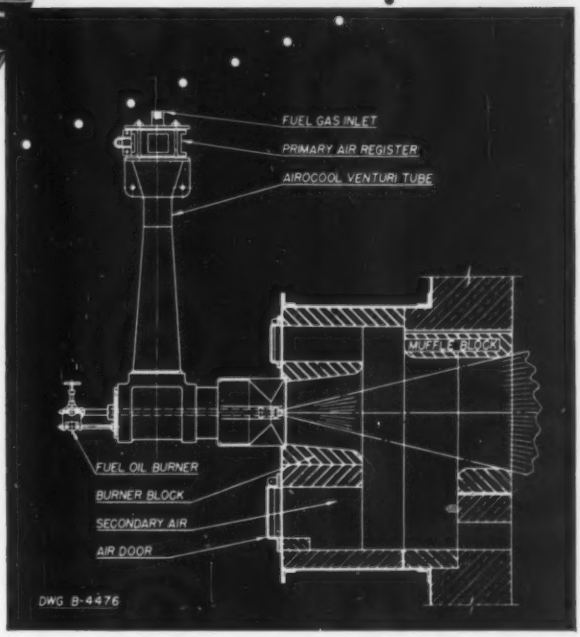
January

8-12.....**SAE,** Annual Meeting, Cobo Hall, Detroit, Mich.



NATIONAL AIROIL OIL-GAS TANDEM COMBUSTION UNITS

Fire World's Highest Thruput Crude Distillation Unit



At Tidewater Oil Company's modern Delaware Refinery, this huge crude furnace now has the world's record capacity of 150,000 barrels per day. It is equipped with National Airoil Burner Company's exclusive Tandem Block Combustion Units . . . easily capable of exceeding the designed capacity of the furnace when burning either liquid or gaseous fuels.

These Tandem Units will burn up to high viscosity residuum oils and/or varying molecular weights of refinery gases. They have high individual heat liberating capacity as well as turn down ratio on natural draft thus avoiding the cost of a blower system. They will operate with low excess air.

Because these high combustion efficiency Tandem Units liberate a large proportion of heat by flame radiation to the heat absorbing surfaces, they increase the days on stream by reducing flame impingement with its accompanying high maintenance cost to tubes, brick work, etc.

NATIONAL AIROIL BURNER

Established 1912
Incorporated 1917

NATIONAL AIROIL BURNER COMPANY, INC.

1284 E. Sedgley Avenue • Philadelphia 34, Pa., U.S.A.

Industrial Oil Burners, Gas Burners and Combustion Equipment

Suppliers Notes...

ROCKWELL MANUFACTURING CO. has elected **Thomas O. Carson** assistant vice president, Meter & Valve Division. Carson, who has been regional manager,

Carson

Shoemaker

central region, will headquarter in Pittsburgh and handle sales east of the Mississippi River. **D. H. Shoemaker,** Pittsburgh district manager since 1957, succeeds Carson as central region manager.

PARKER SEAL CO. has appointed **William Swan** western sales manager. Swan joined Parker Seal in 1956 as a sales engineer in Dayton, Ohio.

CHASE BRASS & COPPER CO., INC.'s, president, **Glenn P. Bakken,** has been reelected president, Copper & Brass Research Association. **E. P. Dunlaevy,** executive vice president, Phelps Dodge Copper Products Corp., has been reelected senior vice president of the association.

GIRDLER-SUDCHEMIE KATALYSATOR G.m.b.H. has started construction of a specialty catalyst plant at Moosburg, near Munich, West Germany. The firm is jointly owned by Sudchemie A.G., Munich, and Chemetron Corp. of Chicago. It was formed in 1959 to market Girdler Catalysts' products.

SCIENTIFIC AND PROCESS INSTRUMENTS DIVISION, Beckman Instruments, Inc., has appointed **William C. Grimes** senior field service engineer. Grimes was field service engineer for the division's western region. He joined Beckman in 1957.

CROWN CORK & SEAL CO. has promoted **Benjamin C. Renne** to district manager, Philadelphia. Renne joined Crown in 1954 as a sales representative, middle Atlantic region.

SHAND AND JURS CO. has named **Vincent J. Salemme** chief engineer for all engineering operations. Shand and Jurs, a subsidiary of General Precision Equipment Corp., manufactures mechanical fittings and gages, and remote supervisory control and data transmission systems.

WILLIAMS BROTHERS CO. has assigned **C. Ray Grosvenor** to conduct special studies of the development of project interests in the petroleum processing field. Grosvenor will headquarter in Tulsa.

THOR POWER TOOL CO. has transferred **Clarence B. Bergren,** formerly manager of Thor industrial sales in Aurora, Ill., to Tynemouth, England, as managing director of Thor Tools, Ltd. **Samuel P. Gartland,** previously regional industrial sales manager in Indianapolis, has been transferred to Turin, Italy, as managing director of FIAP, the firm's Italian manufacturing subsidiary.

PANNELLIT SERVICE CORP. has elected **Warren W. Johnston** vice president, operations. Johnston joined PSC in 1956 as manager, Systems Division. PSC is a subsidiary of Information Systems, Inc.

MITSUBISHI HEAVY INDUSTRIES, REORGANIZED, LTD., Kobe, Japan, will manufacture gas turbines this year under a license and technical assistance agreement with Westinghouse Electric International Co.

WESTON INSTRUMENTS DIVISION, Daystrom, Inc., has named **Ralph L. Shapcott** director of manufacturing and assistant general manager. **James W. Harte,**

Shapcott

Harte

Jr., has been appointed service Division manager. Both men will headquarter at Poughkeepsie, N. Y.

NATIONAL TUBE DIVISION, U.S. Steel Corp., has named **James G. Morrison** manager of sales, New York district office. Morrison joined National Tube in the Atlanta, Ga., sales office in 1922.

U.S. STEEL CORP.'s National Tube Division has appointed **Walter P. Rhodes** general manager, marketing. Rhodes will handle all products divisions and commercial staff functions. He came to the division in 1945.

B. H. HADLEY, INC., has elected **Frank R. Osborne** president. Osborne has been vice president and general manager of the company since 1957. B. H. Hadley specializes in fluid regulation and control devices.

THE FOXBORO CO. has assigned **Charles O. Radden** to head chemical industry sales promotion in the United States and abroad. Foxboro makes industrial instruments.

PETROLITE CORP. has named **A. J. Fox,** formerly assistant to the sales manager, Tretolite Co., sales manager for Petrolite, Ltd., Eastern Hemisphere Division. Fox, who will headquarter in London, will direct sales and service operations in Europe, the Middle East and the Far East.

CHEMICAL CONSTRUCTION CORP. has named **James Logan** and **George W. Chaille** sales engineers, Petroleum and Petrochemical Division. Logan was formerly with Catalytic Construction Corp., and Chaille was with Foster Wheeler Corp.

ACHESON COLLOIDS CO. has appointed **Stanley M. Hunt** to head market development in the New England states. The company has opened a new sales office at Hartford, Conn.

COLEMAN INSTRUMENTS, INC., has named **Roland M. Waters** marketing director. Waters had been marketing manager of Radiation Counter Laboratories, Inc., Skokie, Ill.

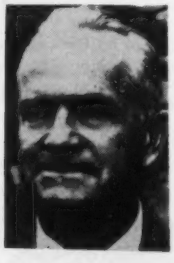
THE RIDGE TOOL INTERNATIONAL CO., INC., has named **Ron Ifould** sales representative for Western Europe. Ifould was with Wallaceburg Brass, Ltd., Wallaceburg, Ont., before coming to Ridge Tool.

CHICAGO PNEUMATIC TOOL CO. has elected **Guy J. Coffey** chairman of the board and chief executive officer. Coffey succeeds **H. Arnold Jackson,** who will continue as a director and chairman of the executive committee. **Norman Readman** has become president replacing Coffey. Readman was previously manager of all the firm's overseas operations.

BYRON JACKSON PUMPS, INC., has promoted **Paul Frisbie** to manager, Plainview, Texas, district office. The firm has also set up a new office at Midland, Texas.

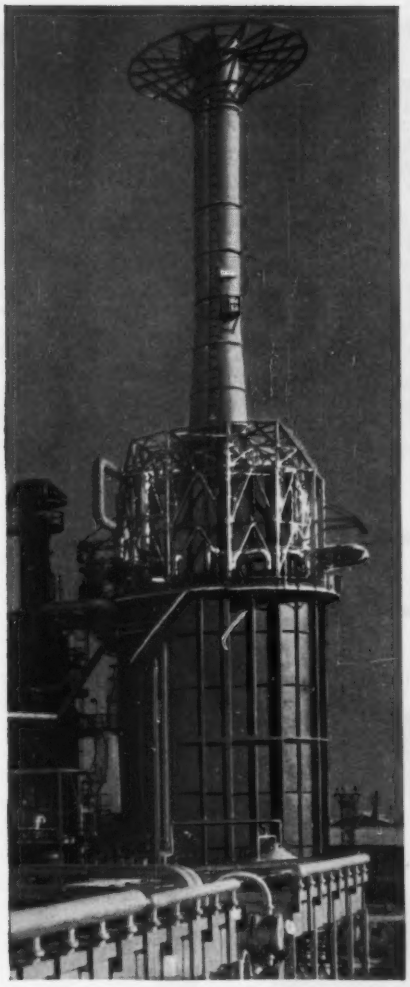
WORTHINGTON CORP. has elected **Fred R. Ellenberger** vice president, international operations. Ellenberger succeeds **S. Riley Williams,** who has retired. Williams will

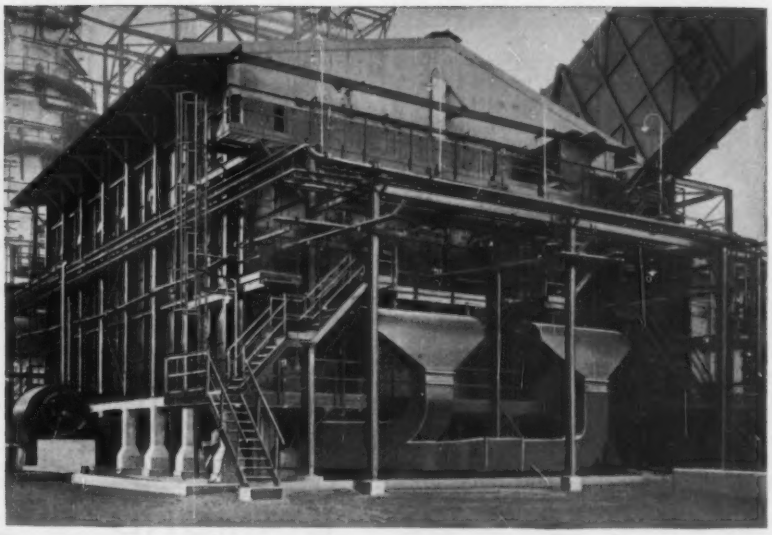
Ellenberger

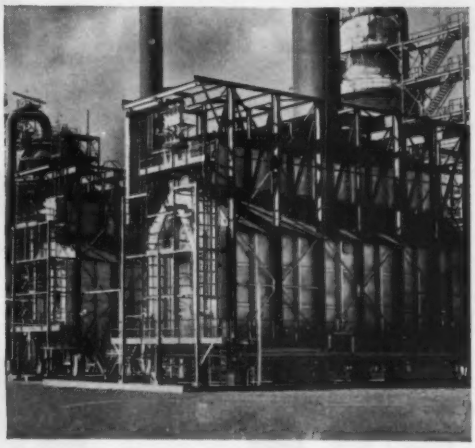


Williams

continue with the company as vice president-consultant. Ellenberger joined the firm in 1938.







8.46 billion Btu/hr since 1958

Let the process industry's own record be your guide in selecting an experienced supplier of direct-fired heaters.

From December 1958 to May 1961, Foster Wheeler processed contracts for the supply of 190 direct-fired heaters. Their total capacity is approximately 8,458,900,000 btu/hr absorbed.

About one-half of these heaters are smaller units with capacities under 30,000,000 btu/hr. They include vertical-cylindrical, cabin and horizontal box types; shop-assembled units and special designs.

Shop-assembled heaters for quick delivery range up to 45,000,000 btu/hr for horizontal box types and up to 30,000,000 btu/hr for packaged vertical-cylindrical units. Individual field-erected units have been supplied in capacities up to 340,000,000 btu/hr and may be furnished in any capacity desired.

The experience revealed in this record is brought to processors through the services of the largest and most experienced group of process and furnace design specialists serving the industry. To get in touch with them, write to Foster Wheeler Corporation, 666 Fifth Avenue, New York 19, New York.

FOSTER WHEELER

NEW YORK TORONTO LONDON PARIS MILAN TOKYO

Suppliers . . .

TRENT TUBE CO., subsidiary of Crucible Steel Co. of America, has elected **Fred W. Beitner** vice president. Beitner joined Trent in 1946 in the Sales Department.

GROVE VALVE AND REGULATOR CO. has named **George F. Rogala** assistant secretary. Rogala, who has been with Grove for 15 years, was chief accountant.

TUBE TURNS PLASTICS, INC., has promoted **Milo H. Buzzee** to engineering manager and **David W. Baird III** to Technical Department manager. Buzzee, who was chief development engineer, joined TTP in 1956. Baird was with E. I. du Pont de Nemours & Co. before coming to TTP in 1960.

ALLERTON CHEMICAL CO., INC., manufacturer of industrial surface coatings and other products, has elected **Julian M. Avery** a director. Avery, a technical advisor to the Ethyl Corp., has also been named a director of Brooks Research, Inc., a subsidiary of Allerton. He graduated from Massachusetts Institute of Technology with a B.S. degree in electrochemical engineering. Avery has been with Ethyl Corp. since 1951.

Avery

JOHN WOOD CO. has promoted **Joseph W. Lenehan** to vice president and director, engineering, Air Pollution Control Division. Lenehan, who will headquarter in Florham Park, N. J., will handle engineering, research and development.

SELAS CORP. OF AMERICA has appointed **George V. Jordan, Jr.,** manager of its new Flotronics Division. Jordan joined Selas as a sales engineer in 1943. Division headquarters are in Spring House, Pa.

GENERAL MILLS' Specialty Products Co. has named **William S. Mitchell** sales manager of industrial oils. Mitchell came to General Mills in 1952 as a research technician.

CRANE CO. has elected **Norman B. Champ, Jr.,** vice president. Champ will head the Midwest Piping Division, Chapman Valve Manufacturing Co., Swartwout Division, and the Cochrane Division.

WAYNE PUMP CO., Symington Wayne Corp., has elected **Charles K. Aaron** president of Wayne Pump Canada, Ltd., Toronto. Aaron was formerly assistant to **A. E. Trafford-Owen,** whom he succeeds. He joined Wayne Pump in 1952.

METAL GOODS CORP. has appointed **Bryan J. Vicars** general line salesman, West Texas and Southeastern New Mexico territory. Vicars has been with Metal Goods since 1952.

PETROLITE CORP.'s Internuclear Co. has named **E. Edward Mason** manager. Prior to joining Internuclear in 1956, Mason was with the Atomic Energy Commission at its Savannah River plant in South Carolina.

COOPER-BESSEMER CORP. has promoted **Ralph L. Boyer** to vice president of advanced planning. Boyer was formerly vice president and director of engineering. **D. L. Gallogly,** C-B's chief engineer, replaces Boyer as head, Engineering Department.

TEXAS ALLOY PRODUCTS CO., INC., Houston, has named **J. P. Ekholm** sales representative for weld clad products.

KAISER ALUMINUM & CHEMICAL CORP., Refractories Division, has elected **Frank M. Cashin** president. Cashin had been vice president and general manager of the division. He joined the corporation in 1943.

CHICAGO BRIDGE & IRON CO. has elected **George E. Borst,** Philadelphia, and **Edward S. Fraser,** Hinsdale, Ill., directors. Borst, a company vice president, is manager of CB&I's eastern sales region. Fraser is vice president of manufacturing.

AMF INTERNATIONAL, division of American Machine & Foundry Co., has appointed **Matthew S. Stolarz,** vice president, general products. Stolarz will direct export activities for the division.

ELLIOTT CO. has appointed **Harlan P. Hostetter** western regional manager, with

headquarters in San Francisco. The western region covers sales in eight western states.

ELECTRORUST-ROOFING CORP. has elected **Frank P. Macdonald** president. Macdonald joined ERP as a sales representative in Dayton, Ohio.

DARLING VALVE & MANUFACTURING CO.'s executive vice president and general manager, **Carl H. Simon,** has been elected to the board of directors, American Standards Association, for a three-year term.

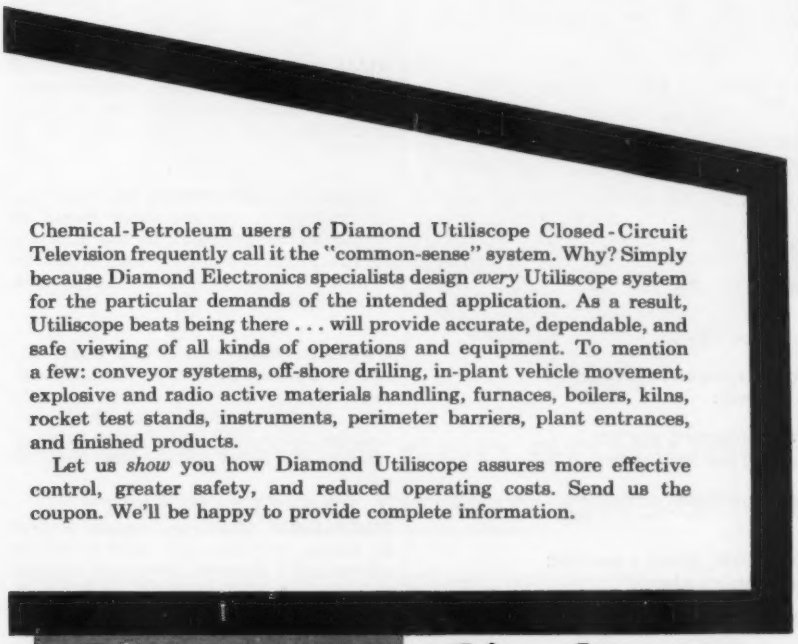
CORNING GLASS WORKS has made **William H. Wheeler, Jr.,** laboratory glassware salesman in the Chicago south area. Wheeler has been a salesman with Corning since 1956 serving in the Seattle-Portland area.

RESEARCH-COTTRELL, INC., has named **Ralph L. Chamberlin** director of international operations. Chamberlin, an officer and secretary of the board of directors, started as a draftsman with the firm in 1934.

PITTSBURGH CHEMICAL CO.'s Industrial Chemicals Division has appointed **Richard E. Durr** sales representative in the eastern regional sales territory. Durr, who will headquarter at Paramus, N. J., will sell chemical raw materials including plasticizers and chemical intermediates.

VULCAN-ASSOCIATED CONTAINER COMPANIES, INC., has elected **David W. Lynch** vice president, sales, with headquarters in Birmingham, Ala. Lynch was general sales manager.

THE "COMMON SENSE" SYSTEM THAT BEATS BEING THERE



Chemical-Petroleum users of Diamond Utiliscope Closed-Circuit Television frequently call it the "common-sense" system. Why? Simply because Diamond Electronics specialists design *every* Utiliscope system for the particular demands of the intended application. As a result, Utiliscope beats being there . . . will provide accurate, dependable, and safe viewing of all kinds of operations and equipment. To mention a few: conveyor systems, off-shore drilling, in-plant vehicle movement, explosive and radio active materials handling, furnaces, boilers, kilns, rocket test stands, instruments, perimeter barriers, plant entrances, and finished products.

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CONTINENTAL-EMSCO CO. has appointed **E. A. "Ed" Dunn** regional manager, Gulf

Dunn

Cavnar

Frames

Gulf Coast region. Dunn, former manager, South Louisiana Division, joined the firm in 1946 as a floorman at the Houston store. He has also served as a sales representative, district sales engineer and district manager. He will headquarter in Houston. Dunn will be replaced as manager, South Louisiana Division, by **Richard Cavnar,** former district manager at Houston. **Vernon Frames** will become manager, Houston district. Frames joined the company in 1948.

BLACK, SIVALLS & BRYSON, INC., has appointed **Edward W. Reif** regional sales manager, mid-continent region. Reif had been product sales manager for controls and specialty products. He joined BS&B in 1942.

REPUBLIC FLOW METERS CO., subsidiary of Rockwell Manufacturing Co., has elected **A. Clark Daugherty** vice president. Daugherty had been executive assistant to Republic's president for four years. He is also a director of Republic and a vice president and director of Republic Flow Meters of Canada, Ltd. Daugherty, who joined Rockwell in 1946, has been manager, Marketing Research Department, and director of public relations. He was elected to the board of directors in 1960.

Daugherty

GROVE VALVE AND REGULATOR CO. has named **John W. Collins** president. Collins was senior vice president and chief executive officer for the company. He has been with Grove Valve for 18 years, serving as an officer since 1947.

GENERAL AMERICAN TRANSPORTATION CORP. has elected **T. M. Thompson** board chairman and chief executive officer. He has been president for the past year. **Spencer D. Moseley,** director and

Biggest News in Protective Coatings Since 1942...

AMERCOAT No. 99

Amercoat No. 99 offers the time tested protection of vinyl coatings plus virtually foolproof application with cost reductions of up to 42%!*

For application with either airless spray or conventional spray equipment, No. 99 is a companion coating to Amercoat No. 33, the *first* practical vinyl maintenance coating. Introduced in 1942, No. 33 is... after 18 years... still protecting more than 200 million square feet of steel structures in the severest corrosive environments. And now, through exclusive Amercoat technological developments, you can have the proven protection of No. 33 PLUS the cost-cutting advantages of No. 99.

- Highest solids content of non-mastic vinyls
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- Labor savings of more than 50% have been reported, with material costs cut 35%
- Can be applied directly over Dimetcote, giving a two coat system unequalled by any comparable system
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You may obtain complete technical data including a cost analysis showing savings you can realize with this coating by writing to Amercoat Corporation, 4809 Firestone Boulevard, South Gate, California.

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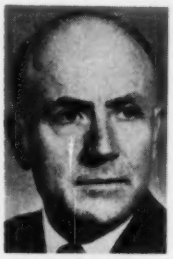
Suppliers . . .

assistant to the president, has been named president. Thompson succeeds **Sam Laud,** board chairman since 1956.

BENNETT PUMP DIVISION, John Wood Co., has named **Angelo J. Perna** chief engineer. He will be in charge of product improvement and new product development. Prior to joining Bennett Pump, Perna was director of engineering at Kaydon Engineering, ball and roller bearing manufacturer, for five years. Perna also worked in research and engineering with Pullman-Standard Co. and Fairchild Aircraft.



Perna

STONE & WEBSTER SERVICE CORP. has elected **Edward J. Murphy** secretary. He replaces **Carl H. Conley,** who has retired. Murphy, assistant secretary since 1954, joined the company in Boston in 1921.

KEASBEY & MATTISON CO. has promoted **James A. Marley** to sales services supervisor for asbestos-cement pipe products at Ambler, Pa. He joined the firm in 1958.

DELAVAN MANUFACTURING CO. West Des Moines, Iowa, has appointed **David B. Miller** sales engineer in the Electro-Sonics Division. Miller was with the Elliott Division of Carrier Corp. as a sales engineer.

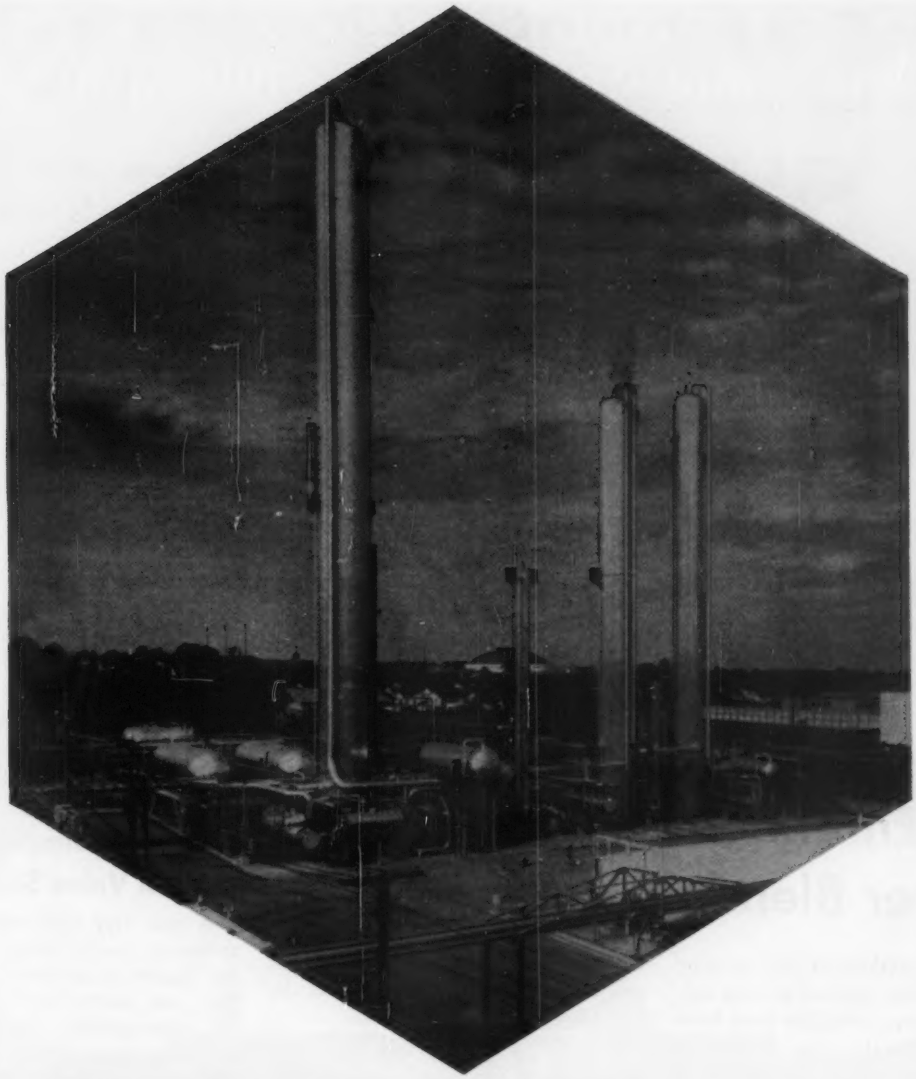
OWENS-CORNING FIBERGLAS CORP. has named **Thomas J. Welly,** Toledo, manager of corrosion protection products sales. Welly, who has been with Owens-Corning since 1955, will handle sales of reinforced plastic anti-corrosion products.

PERKIN-ELMER CORP. has elected **Robert E. Lewis** president and chief executive officer and a director. Lewis has resigned as president of Sylvania Electric Products, Inc.

ROCKWELL MANUFACTURING CO.'s Petroleum & Industrial Meter Division has named **Eldon E. Carlson** western product manager. He will headquarter in Pittsburgh.

MINNEAPOLIS-HONEYWELL REGULATOR CO.'s Electronic Data Processing Division has moved its Washington branch sales office to Arlington, Va. **Donald F. Brosnan,** formerly manager of the division's Detroit office, will be the new branch manager.

RIDGE TOOL CO. has made **Paul Selby** salesman in the Montreal, Quebec, area. He was a sales manager for Crane, Ltd.



now refiners can produce balanced blend gasoline with PENEX®

PENEX processing produces the highly-volatile iso-paraffinic blending fuels which have such excellent performance qualities, good sensitivity and warm-up characteristics, clean burning, and improved lead susceptibility. The best quality gasoline is a balanced blend containing these Penex produced iso-paraffins.

Penex is designed for the continuous catalytic isomerization of normal pentane, normal hexane and mixtures of both. Reaction conditions are extremely mild because of the nature of the reaction and the catalyst used. Conditions selected are such that regeneration is not required, thus reducing capital investment costs, simplifying operation and minimizing maintenance.

UOP offers a wide range of petroleum and petrochemical processes to refiners everywhere in the free world. A variety of technical services are also available from UOP to insure the profitable performance of these processes. Let UOP engineers evaluate your processing needs now.

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MEANS PROGRESS TOMORROW

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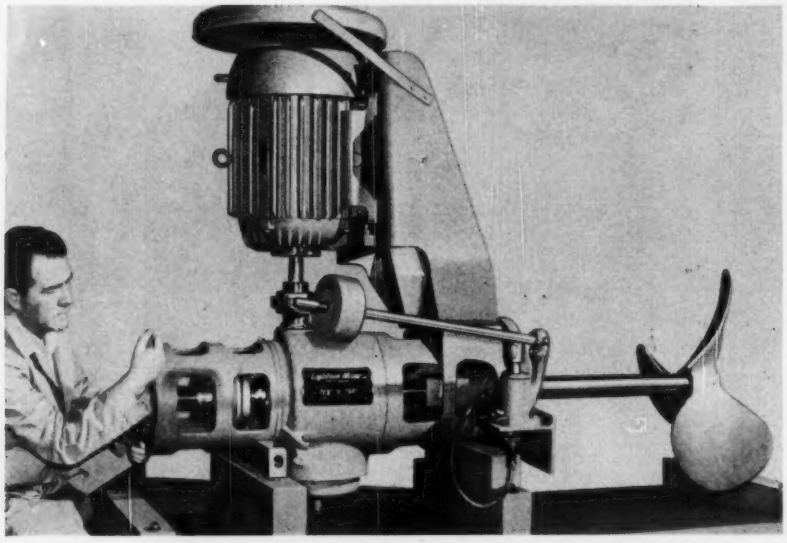
UNIVERSAL OIL PRODUCTS COMPANY
30 Algonquin Road, Des Plaines, Illinois, U.S.A.

For more data on advertised products, use cards, last page.

New Equipment & Literature...

as selected by Frank L. Evans, Jr., Mechanical Engineering Editor



Mixer has low installation and operating costs.

Side-Entering Mixer Has Greater Blending Capacity

Major innovations in side-entering mixer technology applied to fluid agitation in process industries have been incorporated in the new Lightnin NSE mixer line. The new range of models achieves 50 percent greater flow or blending capacity while installation and operating costs are reduced by as much as 50 percent in larger unit sizes.

Three basic sizes for applications ranging from one to 50 hp, are available. Mixers are right-angle spiral bevel gear units with hollow-quill speed reducers developed specifically for side-entering applications.

The addition of larger units to the side-entering line, plus increased flow of these mixers, permit substantial savings in initial investment, i.e., a single 50-hp side-entering mixer will do the job of three conventional 25-hp units.

Additional information is available. Mixing Equipment Co., Inc.

Circle E1 green card, last page

Booklet Trains Engineer In Human Relations

"Supervision for Professional Advancement," takes the engineer another step in training himself and others, in "human relations." The importance of maintaining good supervisory practices is illustrated by the fact that supervisory personnel are the key to uninterrupted production, completion of projects successfully and on time.

Management is interested not only in the bold, creative steps taken in the solution of problems, but equally, in how quickly and profitably these ideas can be put into practical application. Requiring less than 10 minutes reading time, the booklet is free upon request. Western Supply Co.

Circle E2 green card, last page

Hydrogenation Catalysts Described in Data File

Precious metal catalysts used in hydrogenation reactions are described in a new data file. The publication details catalysts of platinum, palladium, rhodium and ruthenium, and outlines guides in selecting catalysts and carriers for specific applications in the chemical and petrochemical industries.

Among the applications are catalytic reduction of functional groups such as aromatic systems, nitro compounds, nitriles, oximes, carboxylic acids, ketones, aldehydes, benzyl derivatives, olefins, and acetylenes.

Examples are given of standard and custom-made precious metal catalysts offered in various forms, including powder, pellets, granules and spheres. Engelhard Industries, Inc.

Circle E3 green card, last page

Slide Rule Simplifies Control Valve Sizing

A new, free slide rule, which simplifies the task of sizing control valves for known conditions of flow, pressure, etc., solves for C_v and corrects for steam quality, gas specific gravity and temperature, and liquids specific gravity and viscosity. Standard slide-rule scales A, B, C, and D are also incorporated. Step-by-step instructions for using the slide rule are provided. Robertshaw-Fulton Controls Co.

Circle E4 green card, last page

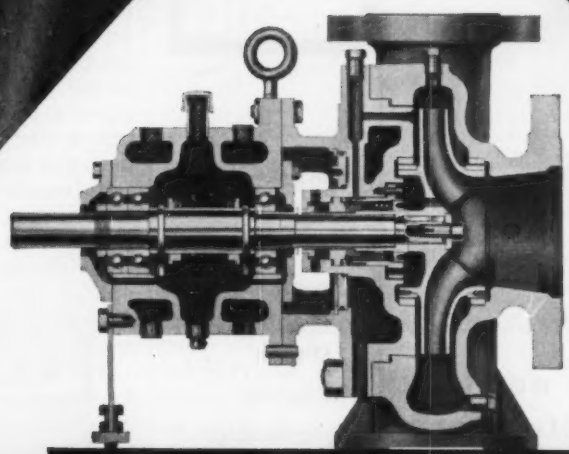
Valve Pressure Drop Data Lets You Make Calculations

A lubricated-plug valve flow program has been started to concentrate on flow characteristics of this valve type and to develop a system whereby customers might calculate pressure drops themselves.

A new 12-page bulletin is the result of this data gathering. By supplying accurate pressure drop data on existing valves, systems designers may now, through the bulletin, select the most efficient and economical valve

Why buy more pump than you need for

HOT
LIQUIDS
?



You take two big bites out of costs when you buy a Goulds Pump that *fits* your hot pumping service. You don't pay for more pump than you use—yet you have expensive pump features that keep maintenance costs down.

The Goulds Model 3775 handles liquids *as hot as 750°F*—and pressures up to 600 psi. Gives you all these features:

1. Cooled seal. Hot pumpage never touches the mechanical seal—because the seal is isolated in its chamber and surrounded by cool, dead-ended liquid. Coolant circulates through jacket to keep seal face to 250°, even when pumpage reaches 750°. A simple adjustment lets you change to external flush or heat exchanger cooling.

2. Cooled feet. Alignment stays true regardless of temperature variations because of centerline mounting and tapped inlet and outlet connections that permit circulation of cooling liquid.

3. Cooled bearings. Water-cooled housings maintain constant bearing temperature for longer life.

BACK PULL-OUT FOR EASY UPKEEP. A millwright alone can remove rotating parts without disturbing pipe connections or driver.

You get maximum economy in spare parts inventory, since all twelve sizes are built on the same bearing frame—one size bearings, shaft and seal for all pumps.

The husky Model 3775 is built to API specs, with a vertically split casing. Capacities go to 1200 gpm and heads to 500 feet.

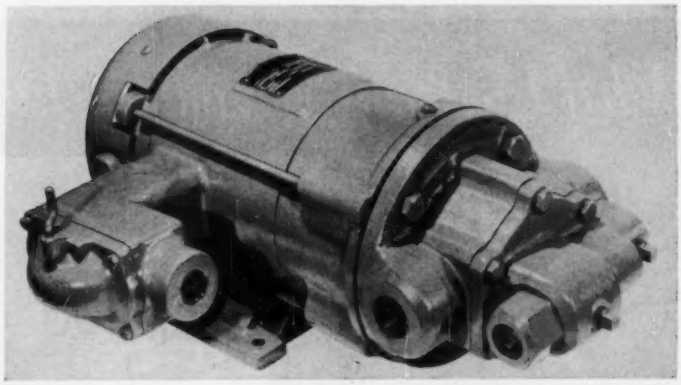
Bulletin 724-1 gives you a more complete look at how Model 3775 can help you cut costs on hot pumping services. It contains specifications, construction details, pressure-temperature chart, and other helpful information. Write to Goulds Pumps, Inc., Dept. PR-71, Seneca Falls, N. Y.

GOULDS PUMPS

for their particular piping needs.

The bulletin lists 85 lubricated-plug valve figure numbers from which the engineer may select data and calculate pressure drop with either the K-values or Equivalent Feet method. Walworth Co.

Circle E5 green card, last page



Motor-Mounted Rotary Pumps Offer New Economy

A new series of motor-mounted rotary pumps for handling clean liquids and solvents (up to 5,000 sus) offers new economy and ease of installation on jobs requiring delivery rates from 10 to 30 gpm at pressures up to 125 psi.

In this compact design, the pump and motor are built as an integral unit with a common heavy-duty shaft supported by the motor bearings. Because the pump is mounted directly to the motor, there is no need for separate pump bearings, a second seal, a coupling, a pump head, or a mounting base. Installation is fast and easy because there is no shaft coupling to cause misalignment, and the pump discharge can be directed to left, right, up or down simply by removing four capscrews and repositioning the cylinder. Each pump is equipped with a built-in relief valve.

The motor-mounted pumps are offered in three basic sizes, 1, 1¼ and 1½ inch. A second series is fitted with special composition vanes to handle a variety of commercial solvents. Each pump size may be ordered with any of five different motors, ranging from ¾ to 3 hp. The motors are all of the explosion-proof type and rated for continuous duty.

Literature, with an easy selection chart, performance curves, and detailed specifications, is available. Blackmer Pump Co.

Circle E6 green card, last page

Design Brochure Gives Data on Heat Exchangers

A new 16-page brochure gives complete data on heat exchangers for the process industries. The brochure contains six pages of detailed engineering data dealing with heat exchanger mechanical and thermal design, installation, operation and maintenance and cost factors. Also included are cross-sectional drawings and illustra-

New handy refractory guide

Here are a few of the technical factors covered...

Abrasive qualities
Acid resistance
Coefficient of expansion
Composition
Compressive strength
Conductivity
Drying shrinkage
Fusion point
Modulus of rupture
Selling properties
Temperature limit

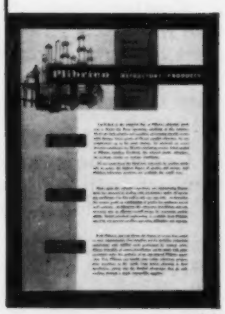
All the facts you need to select the right refractory for every operating condition in the refinery industry

Every physical and performance characteristic of refractories specially selected from Plibrico's complete line is charted for your quick reference.

You'll find grades of Plicast castable refractory with exactly the properties you need...the temperature range, the abrasion resistance, the insulation value. You'll also find select grades of the original plastic refractory, Plibrico Jointless Firebrick, for *any* operating condition.

See how Plibrico provides unified responsibility through complete service...including products, engineering and installation.

WRITE FOR FREE REFERENCE CHART #76 giving detailed data on products for refinery process linings or consult your local Plibrico Field Engineer for technical assistance.



9219

Plibrico REFRACTORIES

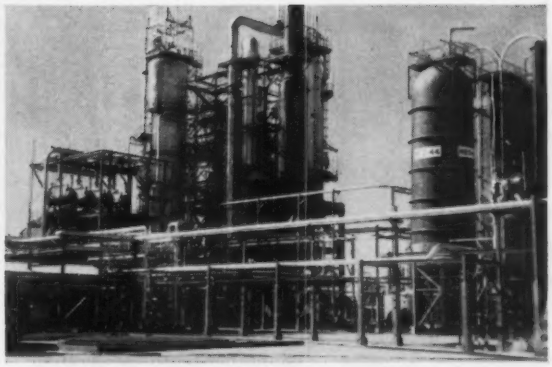
Serving the Furnaces of Industry 24 Hours a Day

PLIBRICO CO., 1812 Kingsbury, Chicago 14 • Canadian Plant: New Toronto, Ont.

Plibrico Sales and Service Throughout the World

REFRACTORY PRODUCTS • ENGINEERING • CONSTRUCTION

CANADA WKE is responsible for marked progress in aggregate preparation. Long experience in mining, handling, concentration and storage of ores and minerals produced this 900 TPH sand and gravel plant.

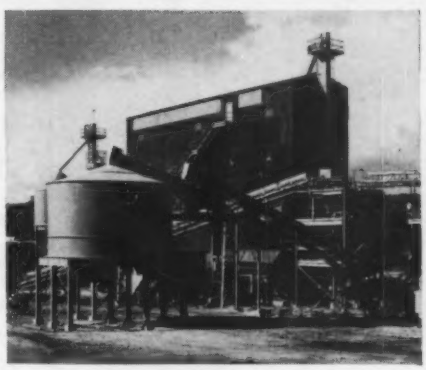


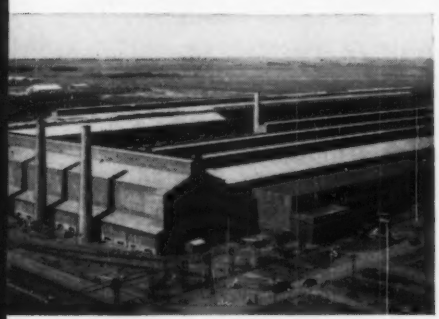
MEXICO This fluid cat cracker is the latest of many major units engineered by McKee in the extensive expansion of Mexico's petroleum industry. McKee's long experience in Mexico was invaluable here. Our experience in your country can prove equally valuable on *your next project.*

ENGLAND Clean-cut design of this blast furnace plant shows the quality of engineering you can expect from McKee-WKE. As early as 1939 McKee set a pattern for the industry with a British ore beneficiation plant of revolutionary design. We can apply thorough, experience-backed knowledge like this to your project—*anywhere.*

McKEE-WKE ENGINEERS WORK ALL AROUND THE WORLD FOR YOUR INDUSTRY

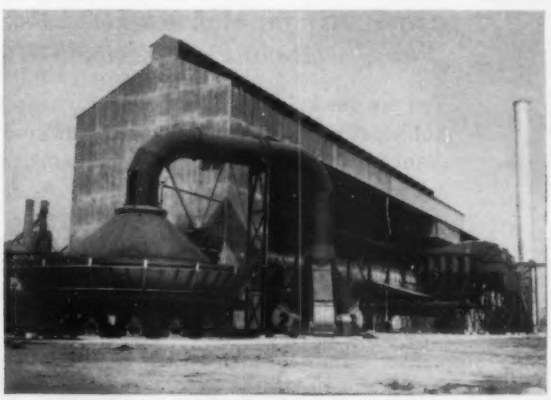
You pick the place, we'll put the plant there—anywhere men and materials can be shipped. We have been doing this for years for companies like yours in the steel, petroleum, chemicals, mining, minerals and related industries. McKee and WKE engineers have left their mark on plants in 49 countries all around the globe—a mark that's easily recognized by advanced design and sound, practical construction. If yours is one of the basic industries we serve, it will pay you well to get the facts on how we can work effectively for you. A call to any of our offices in fourteen cities will get you fast action.





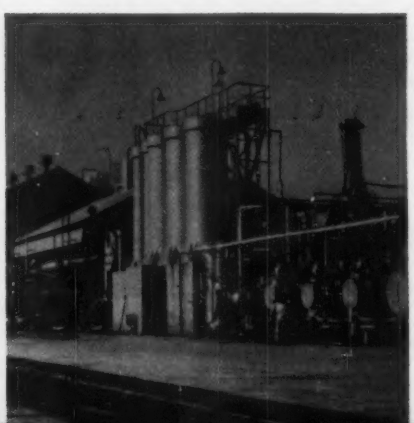
ARGENTINA Decades of steel making knowledge by McKee went into the design and construction of this 700-acre steel plant. New work in progress by McKee will give it largest capacity in Latin-America.

JAPAN Distance was no problem here. McKee engineers added this benzol-acetone solvent dewaxing unit to vacuum distillation and fluid catalytic cracking units designed and built by McKee in Yokohama.



UNITED STATES Thorough knowledge of production methods, from raw material to finished product, were applied in this WKE-built plant which produces milk of lime for use in concentration of copper ore. WKE also designed and built a concentration plant and a copper smelter in this area. Knowledge like this can save you time and money.

BRAZIL Steel men everywhere rely on McKee technical know-how. South America's first large integrated steel plant was designed, built and later expanded by McKee. Operated by McKee-trained local personnel, the two-mile-long plant is an outstanding success. The McKee-designed sintering plant at left was completed recently.



THE McKEE ORGANIZATION

ARTHUR G. McKEE & COMPANY, 2300 Chester Ave., Cleveland 1, Ohio. *Offices:* New York; Union, N. J.; Washington, D. C.; Houston, Texas. *Subsidiaries:* Toronto and Montreal, Canada; Mexico City, Mexico; Sao Paulo, Brazil; Buenos Aires, Argentina; McKee Head Wrightson, London.

WESTERN KNAPP ENGINEERING CO. 650 Fifth St., San Francisco 7, Calif. *Offices:* New York; Chicago; Hibbing, Minn.

WKE

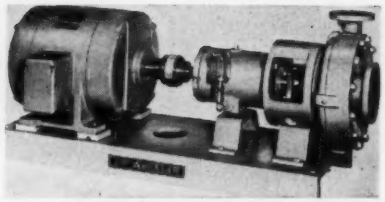
INTERNATIONAL ENGINEERING AND CONSTRUCTION SERVICES

tions together with information showing the construction features and application data on the various types of heat exchangers fabricated by the company. Whessoe, Ltd.

Circle E7 green card, last page

Centrifugal Pumps Designed For Severe Process Service

A new line of end-suction centrifugal pumps, designed to meet the severe service requirements of the



chemical and other process industries, handles oil, condensate, butane, gasoline, liquors, chemicals and other process liquids, either clear or carrying suspensions.

The outstanding features of these pumps are their liberal packing areas, heavy mechanical construction and external dimensions.

The pumps, designated as type BHO, are offered in two sub-classes, Series 350 and Series 300, with 14 pump sizes, ranging from 1 to 5 inches, available in each series. The Series 350 pumps are offered in a variety of stainless steels and other corrosion resistant materials. Cast iron alloys and bronzes are employed in the Series 300 pumps which are designated for general process services.

Both series can pump liquids ranging in temperature from sub-zero to 350° F at pressures up to 250 pounds. All sizes of Series 300, except the smallest, can be close-coupled, using standard motors with NEMA shaft extensions.

A new approach to closure of the casing has been used for the Series 350 pumps. Instead of the studs being drilled into the casing, they are welded directly to the casing. The high quality, full penetration welds have been test proven, and each stud is production-tested.

Complete details available in product literature. C. H. Wheeler Mfg. Co.

Circle E8 green card, last page

Circuit Breaker Time Delay Device Is Unique

To provide maximum reliability in circuit breaker operation—especially in contaminated atmospheres, a hermetically sealed time delay device has been developed, that is unique in the industry. It is installed in low-voltage power circuit breakers for substation load centers.

When overload occurs, a plunger attached to a diaphragm inside the unit is actuated by the tripping armature of the over-current trip device. The diaphragm then slowly forces the oil through the porous plug into the upper chamber. When all the oil is in the upper chamber, the plunger and tripping armature have traveled their full length, and power is then interrupted by the circuit breaker.

One of the key elements that made this unique design of the time delay device possible is the 0.010-gauge diaphragm of Buna-N coated nylon.

After field experience, the following service features of the timing device have stood the test of time: (1)

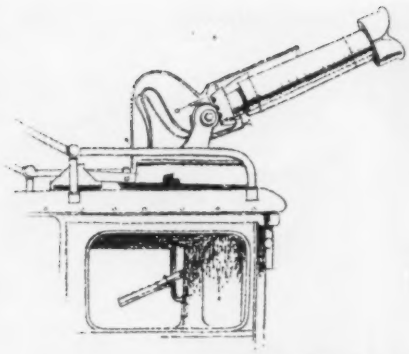
Double Value
WITH
TRIANGLE BRAND COPPER SULFATE
REAGENT *for oil sweetening*
CATALYST *for high octane gasoline production*

You can use Triangle Brand Copper Sulfate two ways: In oil sweetening, it desulphurizes oil, removes mercaptans and other sulphur compounds and malodorous and resinous substances from cracked distillates. As a catalyst for high octane gasoline production, it offers unsurpassed dependability because it is 99+% pure.

Phelps Dodge is your best source for copper sulfate! Get in touch today.

PHELPS DODGE REFINING CORPORATION NICHOLS TRIANGLE BRAND CHEMICALS NEW YORK

phelps dodge refining corporation
300 PARK AVENUE ■ NEW YORK 22, NEW YORK



ROCKWOOD DELIVERS MORE FIRE FIGHTING POWER—

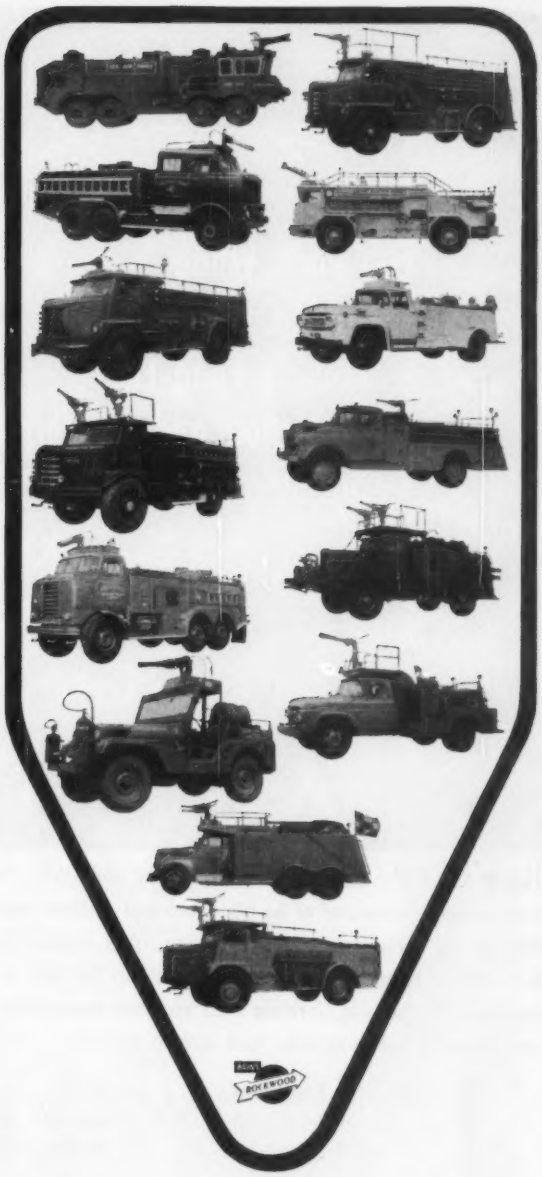
extinguishes faster

Rockwood specialty FOAM Fire-Truck equipment provides greater fire-fighting punch to meet any situation fast and make manpower more effective! Why? Because it adapts quickly to changing conditions . . . hits harder and faster.

There's volume and versatility to spare in Rockwood turret nozzles. They are immediately adjustable to fight fire four ways: with FogFOAM — Solid FOAM Stream — WaterFOG — Solid Water Stream.

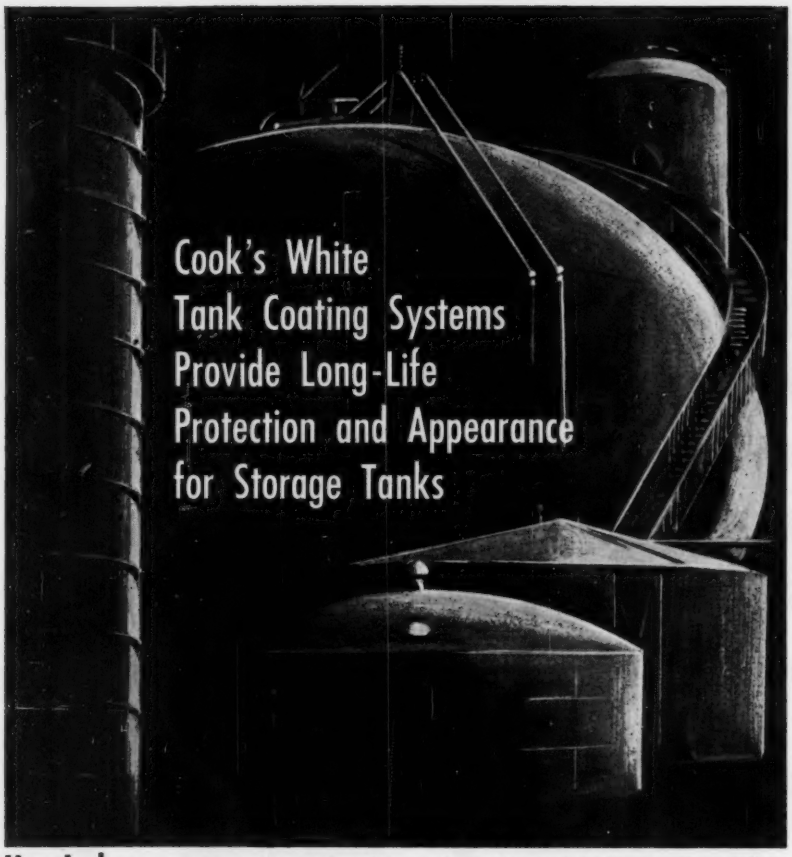
And Rockwood FOAM Fire Truck Proportioning Systems provide close control of FOAM liquid proportioning *automatically* — another vital step in the efficient use of manpower.

Rockwood Handline, Ground-sweep, Under Truck Nozzles and custom designed specialty parts combine to round out the complete line of FOAM equipment . . . the most advanced, most effective tools for fire protection, regardless of your particular needs. For details, write Rockwood Sprinkler Company, Portable Fire Protection Department, 501 Harlow Street, Worcester 5, Mass. Distributors in all principal cities. Rockwood Sprinkler Company, A Division of The Gamewell Company, A Subsidiary of E.W. Bliss Company. *Rockwood engineers water . . . to cut fire losses.*



ROCKWOOD

PORTABLE FIRE FIGHTING EQUIPMENT

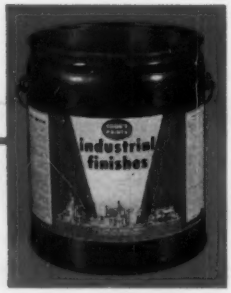


Here's how: Both Cook's Tank White, and Cook's Tankshield One-Coat White are specially formulated to be gas proof and mildew resistant . . . to provide tough, long-lasting protection against corrosion. And highly reflective Cook's whites repel hot sunrays, keeping evaporation losses within the tank to a minimum. Cook systems are also self-cleansing . . . retain their excellent appearance. For long-term dividends, invest now in Cook's exterior tank coating systems.

Cook's Tank Paint White is a long-oil alkyd resin base finish with years of proven durability. Ideal for both new and old tank installation . . . it provides good build and a tough film right from the start.

Cook's Tankshield-A One Coat White is a long-oil alkyd resin base finish, and Cook's Tankshield-S One-Coat White is a long-oil epoxy ester base finish with extra resistance to mild chemical and coastal corrosive atmospheres. Both save you important money on application costs. Under normal outdoor spraying conditions, 3 mils wet film thickness may be applied with one pass of the spray gun—and three such passes may be made without danger of sagging. Result: a dry film thickness of 5 to 6 mils with only one coat.

Investigate Cook's white tank coating systems now. And note this—in addition to whites, Cook's can supply grays, aluminums, pastels or any other desired tank color. **For tanks, Cook's has it!**

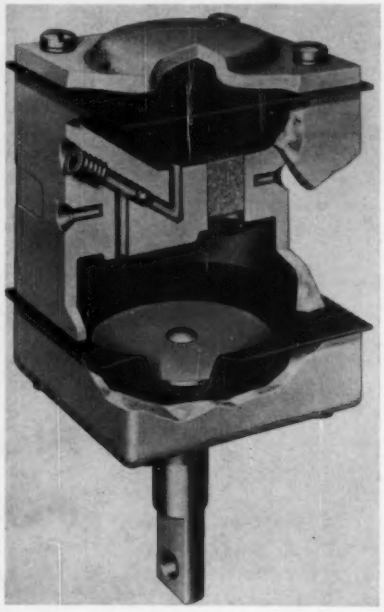


COOK'S PAINTS

COOK PAINT AND VARNISH COMPANY

KANSAS CITY	DETROIT	HOUSTON
P. O. Box 389	P. O. Box 5507	P. O. Box 3089
GRand 1-4800	UNiversity 1-1000	CApitol 8-2391
Teletype KC584	Teletype DE293	Teletype HO29

New Equipment . . .



sealed construction prevents any malfunction because of dust, humidity, and corrosion; (2) timing is very accurate; (3) reliability of operation is maintained even after many months of inaction. Allis-Chalmers Mfg., Co.

Circle E9 green card, last page

Glass Fiber Insulation Has Wide Temperature Range

"Pabco-Glas," a new line of glass fiber insulation, has a temperature range from —120° F to 600° F.

Included in the line are pipe, duct, equipment and low temperature insulations that are designed to meet practically all industrial needs.

Design details are available. Pabco Ind. Products Div., Fiberboard Paper Products Corp.

Circle E10 green card, last page

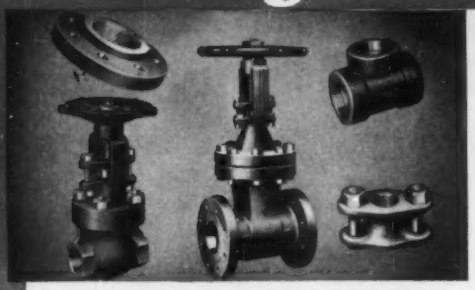
New Oil Thief Design Has Positive Closing Valve

Said to be the first major design change in twenty years, a new positive-closing, easy opening oil thief incorporates a trouble-free, full-opening, side-mounted shutter valve, which can be cocked with just two fingers. Tripping is accomplished by a slight pull on the single line or at a pre-set distance off tank bottom by means of a calibrated trip rod.

Spark-proof construction is of cadmium-plated cast brass or aluminum. The 2-inch barrels, graduated

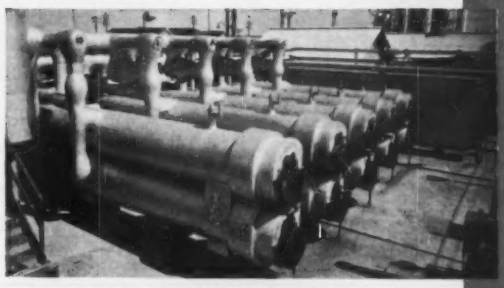
Vogt PRODUCTS

SERVING THE PETROLEUM INDUSTRY SINCE 1880



FORGED STEEL VALVES & FITTINGS FOR TOUGHNESS AND TROUBLE-FREE SERVICE

Forged from carbon and alloy steels, Vogt valves, fittings, flanges and unions are built to safely handle liquids and gases at high pressures and temperatures in the modern petroleum refinery and petro-chemical plants. The complete line includes flanged, screwed and socket weld end globe, gate and check valves—ells, tees and crosses—couplings—bushings—plugs—unions—flanges and flange unions—and weld caps.

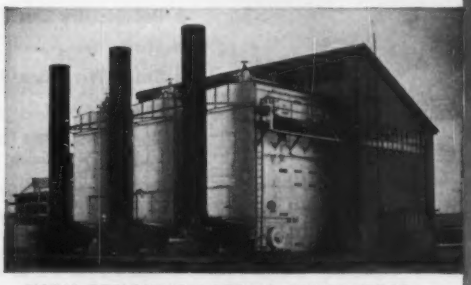


PROCESS EQUIPMENT FOR EVERY SERVICE

Vogt constructs process equipment in wide variety to all Codes. Stills and towers, oil chillers, crystallizers, heat exchangers, molding machines, etc., serve in the manufacture of oils, greases, 100 octane gasoline, synthetic rubber, chemicals and related products around the world.

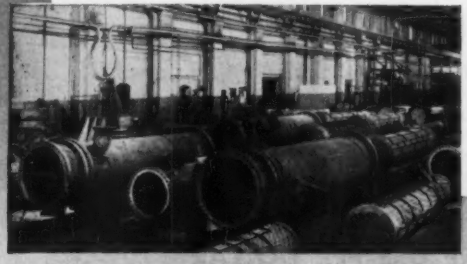
MORE REFRIGERATION TONNAGE AT LESS COST

More than 70 years of engineering and manufacturing experience is incorporated in Vogt refrigerating and ice making equipment. Compression Systems and Tube-Ice Machines in a wide range of capacities serve industrial and processing plants and institutions here and abroad.



HIGH EFFICIENCY STEAM GENERATORS

Vogt steam generators are designed to give maximum rating in a minimum of space, with high efficiency and low maintenance expense. Bent tube and straight tube designs are available for solid, liquid or gaseous fuels to meet every power, process or heating requirement.



SPECIAL MATERIALS COMBAT CORROSION AND PRODUCT CONTAMINATION

Our modern shops produce a wide variety of equipment from special metals and alloys to fight corrosion and product discoloration or contamination. Fabrication procedures insure that corrosion resistant properties of welds will match that of the materials used to construct the equipment.

HENRY VOGT MACHINE CO., LOUISVILLE, KY.

SALES OFFICES:
New York, Chicago, Cleveland, Dallas, Camden, N. J., St. Louis, Charleston, W. Va., Los Angeles

PRODUCTS FOR REFINERIES, CHEMICAL PLANTS, POWER PLANTS AND PROCESS INDUSTRIES

Write for literature, Dept. 24A-GPR

For more data on advertised products, use cards, last page.

New Equipment . . .

in ¼-inch divisions, are available in tempered Pyrex, aluminum or plastic.

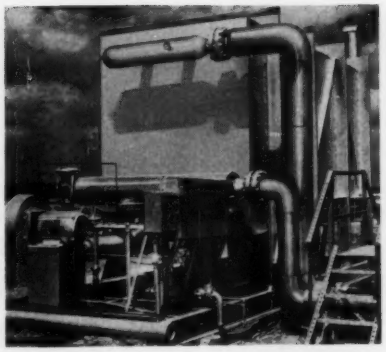
Twenty-four models in four sizes (12, 16, 18, 24-inch) comprise the line. Full information is available. W. H. Curtin and Co.

Circle E11 green card, last page

Unique Furnace Solves Process Heating Problems

The Uniflux Heat Exchanger, a unique new product has been engineered to solve many problems of combustion efficiency and safety normally encountered in process heating. The most important of these is uniform heat around the periphery of each tube and along each tube length. This enables much higher heat-flux rates without exceeding safe-tube, maximum metal skin temperatures. Some important special applications:

- Burning low pressure fuel gas, including flare gas, with only a few inches wc fuel pressure required.
- Utilization of gas turbine exhaust gases as combustion air for atmosphere or pressure discharge.



- Generation of inert gas for atmospheric pressure discharge with waste heat recovery by generation of steam or heating process fluids.
- Conversion of carbon monoxide in flue gas and utilization of waste heat by process heating or steam generation.
- Waste disposal with waste heat recovery.
- Low weight and compactness required.
- Intermittent heating.
- Heat sensitive process stocks.
- Utilization of low Btu fuel gases.
- Utilization of hydrogen sulfide or acid gases as fuel.
- Chemical reactions combined with process heating. Black, Sivalls & Bryson, Inc.

Circle E12 green card, last page

Electrical Equipment Text Simplifies AC-DC Theory

The newly revised 48-page "Catechism of Electrical Machinery" presents in a simple form the most important theoretical and practical features of the common types of direct-current and alternating-current motors, generators and control equipment.

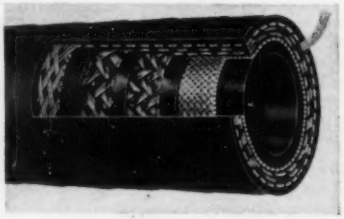
It is intended to familiarize those interested with electrical terminology and phenomena. The text is illustrated with electrical rotating machines and allied equipment. Fairbanks, Morse & Co.

Circle E13 green card, last page

Controller Gives Accurate Off-On Process Control

A new electronic proportional controller provides accurate, dependable, proportional off-on process control with almost imperceptible cycling, and will not permit process conditions to exceed pre-set limits. Used in conjunction with primary instruments, such as indicators or indicating re-

R/M HOSE . . . *First for Service*



at the Refinery

Non-Burst SUPER-MASTER BW Steam Hose

- Practically Burst-Proof
- Static Wire
- Steel Wire Braid Reinforced
- Butyl Cover
- For Pressures to 200 lb—(388° F)

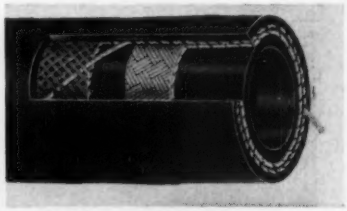
Preferred by safety engineers for flash-fire protection, clean-up . . . for temporary dock-to-ship steam lines to clean vessels and tank cars. Maximum strength and flexibility . . . maximum safety. Made with neoprene cover to stand heat and weather. Write for Bulletin M630.

for Industrial and Home Delivery

Underwriters' Labeled HOMOFLEX PROPANE Hose

- Light, Flexible as a Rope
- Mandrel Made, Kink-Proof
- Braid Plies
- Stainless Steel Static Wire
- Hycar Tube, Neoprene Cover

Easiest hose to handle from tank truck to supply tank. Labeled by Underwriters. Meets specifications of state regulations covering use of liquid petroleum gases. Uniform inside and outside diameters for safer, easier coupling. Write for Bulletin M630.



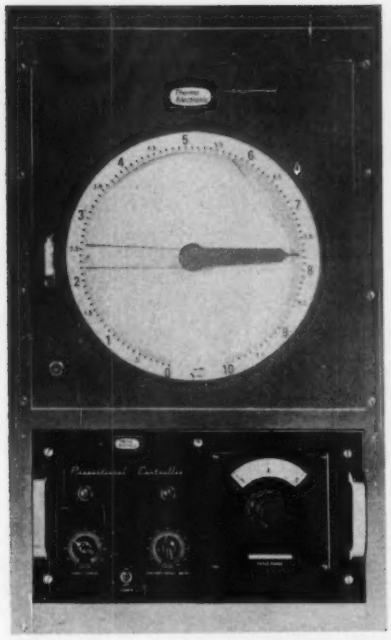
SPECIFY R/M HOSE FOR "*MORE USE PER DOLLAR*"

RAYBESTOS-MANHATTAN, INC.

MANHATTAN RUBBER DIVISION · PASSAIC, N. J.

ENGINEERED RUBBER PRODUCTS

RM-130



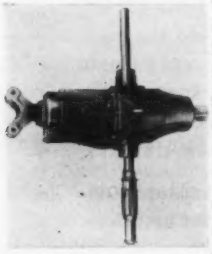
corders having transmitting slidewires, this proportional controller provides accurate control of practically any process; temperature, pressure, pH, chemical concentration, liquid level, etc. Operation and adjustment are simple and easy. Instrument accuracy is ¼ percent of controller span as referred to accuracy of primary instrument.

Design details are available. Thermo Electric Co., Inc.

Circle E14 green card, last page

Lightest 2" Impact Wrench On Market Is A Rugged Tool

The new CP-616 impact wrench, the lightest 2-inch capacity air-operated wrench on the market, is a rugged, hard-hitting tool. It is designed for everyday use under the toughest conditions such as those encountered in refineries and chemical processing plants.



Equipped with a roll-type side throttle handle and a convenient dead handle, the wrench handles easy. It features a malleable iron clutch housing. However, a lightweight aluminum housing is also available at a weight reduction of 10 pounds.

For ease of operation it is equipped with a double-grip spade handle and a suspension bail. Chicago Pneumatic Tool Co.

Circle E15 green card, last page

20-Page Motor Brochure Expedites Selection

A 20-page comprehensive technical brochure covers data on all the company's motor lines in the pumping field to expedite the selection of the optimum motor or drive for each specific pump application.

The new brochure is indexed so that motors and drives may be identified as to construction type (solid-shaft (hollow-shaft, submersible, horizontal, close-coupled, right-angle geared drives, extended-base, NEMA base, etc.): as to enclosure (weather-protected, drip-proof, totally-enclosed, explosion-proof, sealed, and weather-proof); as to thrust (high, medium, normal); and as to company type designation.

Condensed specification data on the various pump motors and drives include ratings, dimensions, thrust capacities in pounds, speeds, frame sizes, ratios and selection charts (for gear drives), and electrical specification material. U.S. Electric Motors, Inc.

Circle E16 green card, last page

Temperature Transmitter Described in Bulletin

A new eight-page specification outlines features, specifications and ordering information on the company's new pneumatic temperature transmitter. This transmitter uses a filled thermal system and transmits a standard 3-15 psi signal which varies in proportion to changes in the measure temperature. Complete specifications on gas and mercury-filled systems available with transmitter are included in the sheet. Minneapolis-Honeywell Regulator Co.

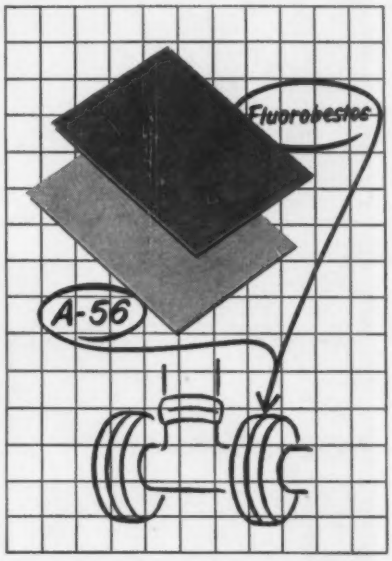
Circle E17 green card, last page

Jet-Powered Clarifier Has Simplified Agitator

A new water-jet-powered precipitator is described as a sludge blanket type, in which the jet effect of water ejected from the tips of the agitator is the sole driving power required for the agitator unit. This design eliminates both the electric motors commonly needed in this type clarifier and the catwalks and bracing usually re-

R/M CAPABILITY DOES IT AGAIN!

Develops these outstanding gasket materials



FLUOROBESTOS...for LOX and cryogenic service • A-56...for flange temperatures to 1100°F

R/M FLUOROBESTOS® is a high grade, long-fiber asbestos unwoven sheet thoroughly impregnated with Teflon.* It has the same sealing and physical characteristics as compressed asbestos sheet, with the added benefits of Teflon. Deformation under load at 500°F (2000 psi) is only 0.1%.

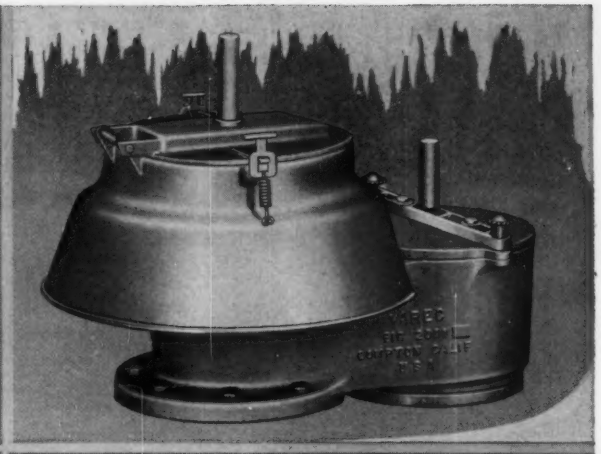
R/M No. A-56 is a compressed asbestos sheet made from spinning-grade long asbestos fiber and a nonreverting compound binder. Average tensile strength 8000 psi. The only compressed asbestos sheet made commercially in thickness of .008 in. ±.001 in. It has high heat resistance—withstands flange temperatures of 900 to 1100°F where internal temperatures are as high as 1400°F.

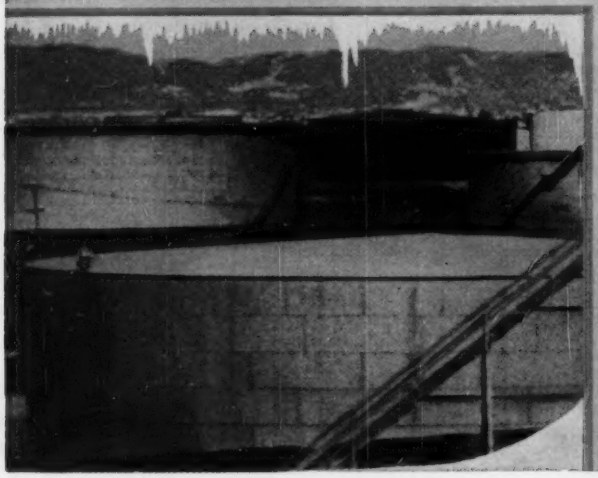
Write for our Mechanical Packing and Gasket Materials Catalog. And remember, when ordering gaskets from your cutter specify R/M materials. Sheets are available from your authorized R/M distributor.

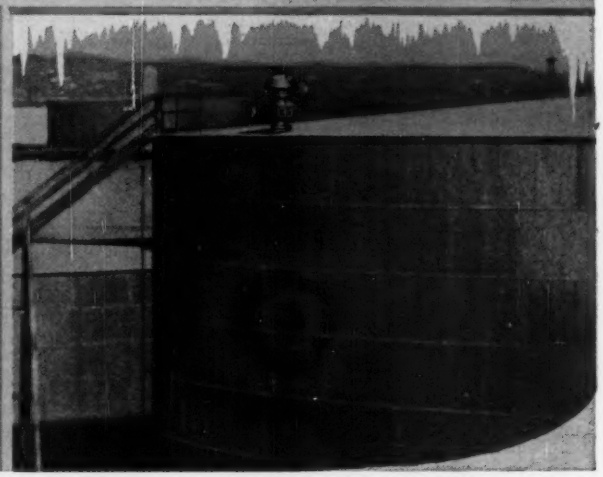
*Registered trademark for Du Pont fluorocarbon resins

RAYBESTOS-MANHATTAN, INC.
RM PACKINGS
PACKING DIVISION, PASSAIC, N.J.
MECHANICAL PACKINGS AND GASKET MATERIALS

For more data on advertised products, use cards, last page.







MODERNIZE YOUR TANK FARM NOW

with the new Varec All-Weather Breather Valve that works perfectly in -60° winters and +125° summers.

Here's all-weather performance that's been *proven* through two full years of Eastern Canada's roughest climate...frigid winters...hot, humid summers. Yet never once did Varec's rugged new Fig. 2000-61 ALL-WEATHER Breather Valve fail to operate perfectly. What's more, this petro-chemical plant can look forward to the continuation of this 100% performance for many tough seasons to come.

By modernizing your tanks with this new Varec ALL-WEATHER Breather Valve, you are now assured of tank safety and vapor saving efficiency *the year around.*

NEW FIG. 2000-61 MODEL...
TWO-WAY PROTECTION AGAINST FREEZE-UP.

Here's how Varec engineers have solved the cold-weather problem: First, both pressure and vacuum pallets utilize a flexible diaphragm of special non-frosting, icing-resistant material. This eliminates possible freezing between pallet and seat ring.

Second, a special non-frosting, icing-resistant compound is used to coat the pallet perimeter and stem, guide-posts and tip of seat ring. Ice and snow scrape free when the pallet lifts.

For complete information on the Varec Fig. 2000-61 ALL-WEATHER Breather Valve, write for Varec Bulletin No. CP-2701, Dept. PR-1500-3.

"Varec"
TRADE ® MARK

THE VAPOR RECOVERY SYSTEMS COMPANY
2820 North Alameda Street · Compton, California

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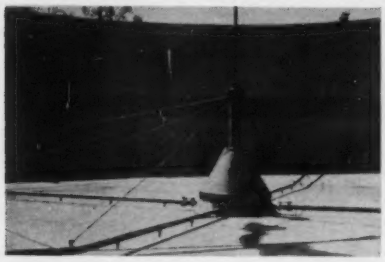


quired for support and access to the motor. The agitator rotates on a stub spindle and requires no overhead support.

In operation, raw water and chemicals are pre-mixed and introduced through an inlet at the center of the tank beneath the agitator hub. A conical deflector, on the agitator hub, directs the water-chemical mixture outward across the tank bottom. Reaching the tank wall, the fluid mixture tends to rise but is redirected back to the center by a horizontal baffle on the tank wall. In this manner, a rolling current pattern is established.

Water chemicals and sludge are kept in intimate mixture for maximum precipitation. A very effective sludge blanket is formed and maintained in suspension. Sludge and heavy particles settle to the bottom, clarified water is drawn off the top of the tank. The Permutit Co.

Circle E18 green card, last page

35 Centrifugal Pumps Based On Six Shaft-Sized Groups

Two new designs of double-volute, single-stage centrifugal pumps incorporate an axially split case that provides for unusually easy access. Neither suction nor discharge piping need be removed and bearings, packings, seals and the impeller can all be reached in minutes. Npsh is minimum.

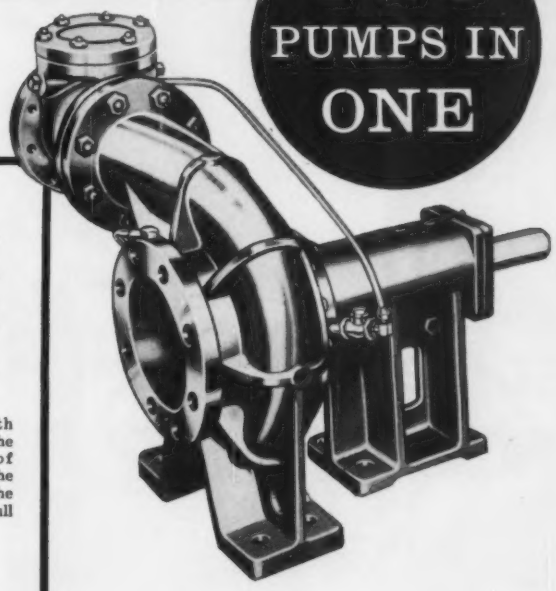
Type DS is a water-cooled unit produced in 22 sizes in capacities up to 13,000 gpm with a 375-foot differential head. It operates up to 350° F.

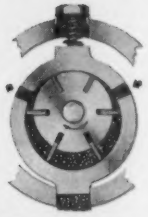
Type DL is an air-cooled unit produced in 13 sizes in capacities up to 6,000 gpm with a 375-foot differential head. It operates up to 250° F.

For maximum parts interchangeability all 35 sizes are based on only six shaft-size groups. Various bearing types may be chosen. Parts in liquid

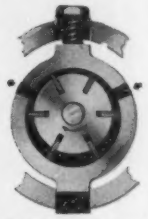
OVERCOME CRITICAL NPSH CONDITIONS WITH *ROTO-PRIMES*

TWO PUMPS IN ONE

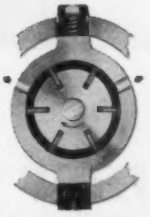




Full Priming—With air or vapor in the lines, pressure of spring on top of the movable slide holds the priming pump in full priming position.



Partial Priming—As the pump evacuates air and vapor from the lines, liquid pressure builds up on the underside of the slide, moving it upward toward neutral.



Neutral—When all air and vapor are removed, liquid pressure equalizes spring pressure and the pump automatically slides into neutral...where it remains until air and vapor again appear in the system.

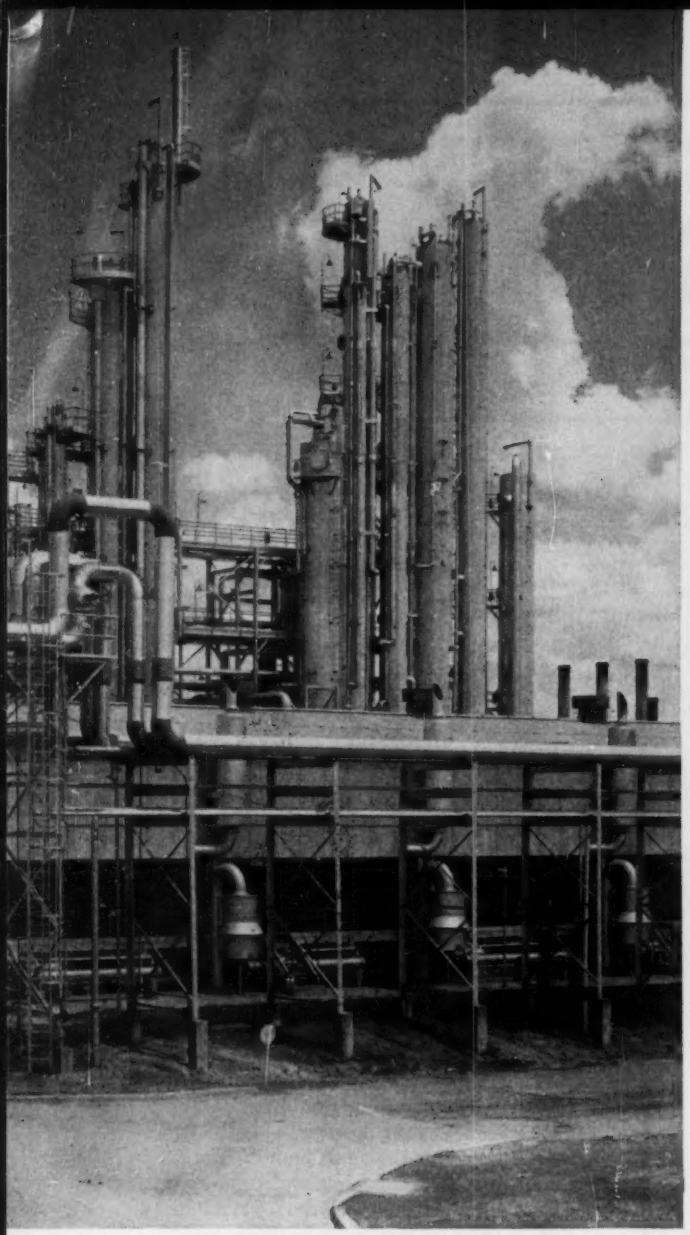
Having trouble with loss of available NPSH when pumping liquid hydrocarbons? Here's your answer — Gilbarco Roto-Prime centrifugal pumps. Roto-Primes are a unique integral combination of a high efficiency centrifugal pump and a variable-capacity positive vane type. Vane pump automatically goes into operation whenever air or vapor enters the centrifugal inlet, providing fast, positive automatic self-priming. These pumps, therefore, *will continue to operate when available NPSH drops below normal requirements.* The 4" x 3" models, as an example, will pump air or vapor from 50 feet of four-inch pipe in less than 60 seconds. Capacities up to 1,600 G.P.M.

Write today for catalog and full information:

Gilbarco

Gilbert & Barker Manufacturing Co.
West Springfield, Mass.
Toronto, Canada

For more data on advertised products, use cards, last page.



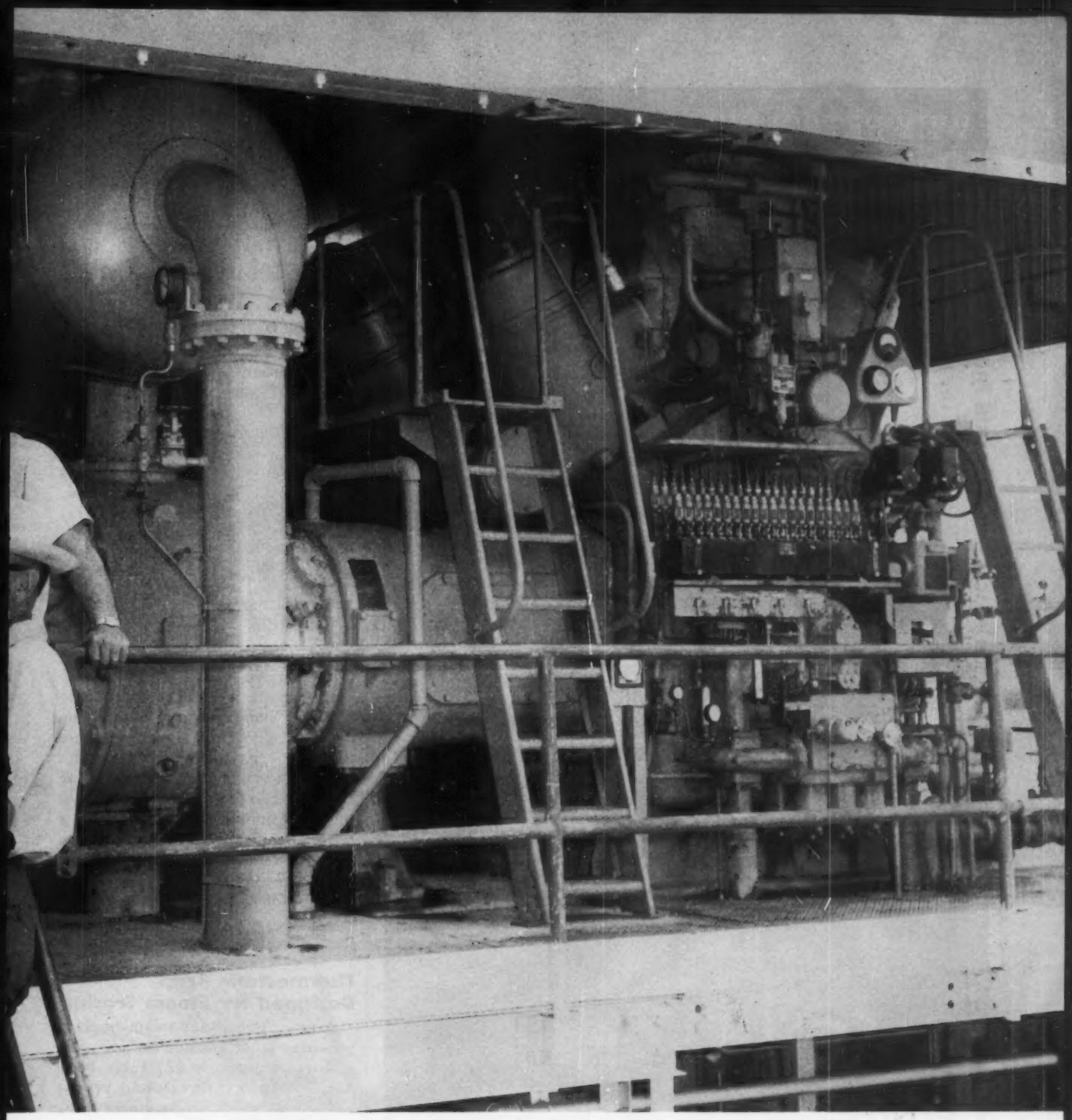
Hydrocarbon cracking plant produces ethylene and propylene for polyethylene and polypropylene plastics, ethyl alcohol and aldehydes. Compressor building in foreground houses 5 Cooper-Bessemer GMV compressors. In an adjacent building are 5 GMVA units.

Discussing conversion of several 1350 hp GMVA-10 compressors to series turbocharging for greater fuel economy . . . Foreground, left to right: C. W. Woltz, Manager of C-B's Shreveport office; E. R. McWhorter, Ass't. Superintendent of Texas Eastman's cracking plant. Background: Nelson Barksdale, Maintenance Supervisor of Texas Eastman's cracking plant; Joe E. Geurin, Service Engineer of C-B's Shreveport office.

How Cooper-Bessemer on-the-spot service helps Texas Eastman

Since their beginning in 1950, Texas Eastman production facilities in Longview, Texas, have been continuously expanded and improved. And, from the start of this program of progress, Cooper-Bessemer equipment and service have played an important part.

Cooper-Bessemer gas engine compressors have vital roles in this vast group of processing plants. Today, 32 of these units are in service, most of them 'round the clock.



The performance of this C-B equipment is backed up at all times by Cooper-Bessemer *on-the-spot service* . . . nearby application engineers, service engineers and spare parts warehouses . . . to assure reliability and to incorporate the latest C-B advancements in Texas Eastman facilities.

Call our nearest office for assistance in planning *your* compression and power facilities.

BRANCH OFFICES: Grove City • New York • Washington • Gloucester • Pittsburgh Mount Vernon • Detroit • Chicago • Minneapolis • St. Louis • Kansas City • Tulsa New Orleans • Shreveport • Houston • Greggton • Dallas • Odessa • Pampa • Casper • Seattle San Francisco • Los Angeles

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COMPRESSORS: RECIPROCATING AND CENTRIFUGAL
ENGINES: GAS • DIESEL • GAS-DIESEL
JET-POWERED GAS TURBINES

WHY PETROLEUM PROCESSORS ARE BEGINNING TO GENERATE THEIR OWN GAS SUPPLY

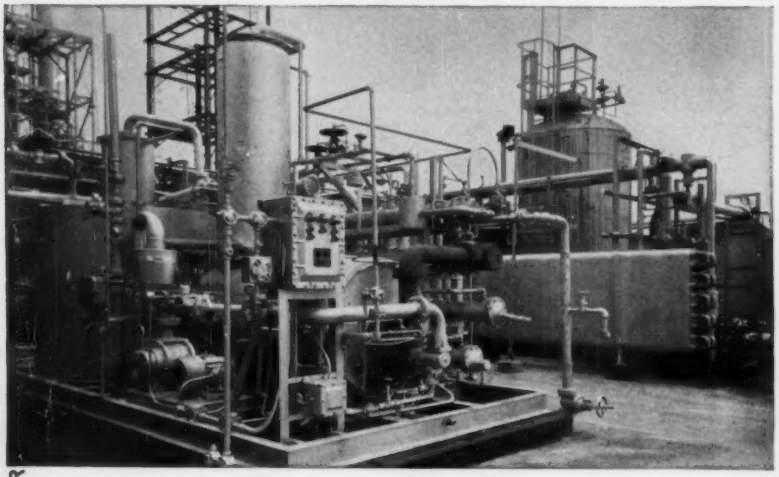
The new "packaged" type generator developed by Gas Atmospheres engineers, that drastically reduces gas costs even for minimum users, is a big reason why more petroleum processors are generating their own gas.

INCREASED USE OF GAS, too, is a factor. The more gas required the greater the savings. Instead of an "incidental" it becomes a major area of cost reduction.

FACTORY-TESTED SYSTEMS that come completely assembled can be put "on line" in a fraction of the time formerly required. No job-site construction is required.

STEP UP IN UNIT SERVICE provided by Gas Atmospheres' Service Department to cut down time to an absolute minimum on any make of generator is another reason why generators are selling better in the petroleum industry.

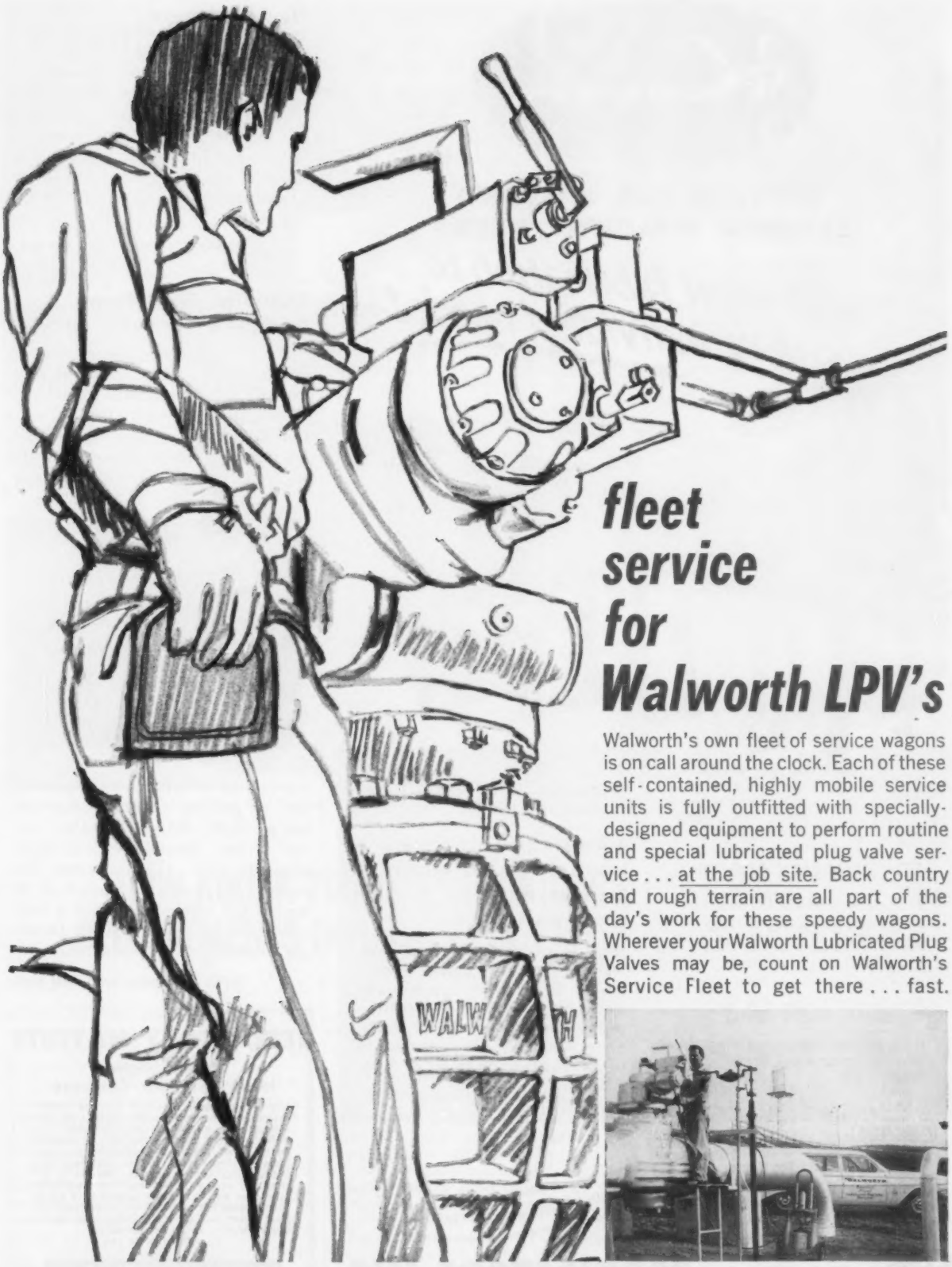
Texaco, Inc. uses this 10,000 cfh nitrogen/carbon dioxide Gas Atmospheres generator in the production of oil additives. A new 20,000 cfh unit was recently delivered.



PACKAGED GAS SYSTEMS are designed and built for the production of nitrogen, carbon dioxide, hydrogen, inert, reducing and annealing gases, as are complete drying and purification systems, by *Gas Atmospheres, Inc., 3855 West 150th Street, Cleveland 11, Ohio.*

gas Atmospheres, inc

PETROLEUM PROCESSING PETROLEUM PROCESSING PETROLEUM PROCESSING



fleet service for Walworth LPV's

Walworth's own fleet of service wagons is on call around the clock. Each of these self-contained, highly mobile service units is fully outfitted with specially-designed equipment to perform routine and special lubricated plug valve service . . . at the job site. Back country and rough terrain are all part of the day's work for these speedy wagons. Wherever your Walworth Lubricated Plug Valves may be, count on Walworth's Service Fleet to get there . . . fast.

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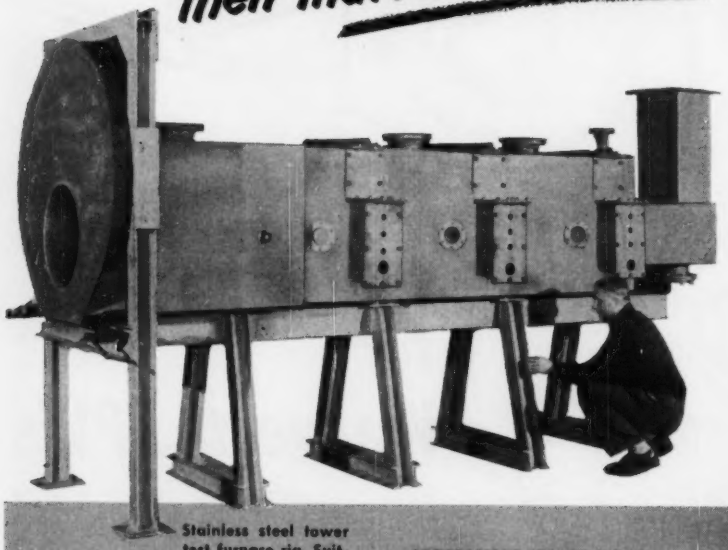

Stainless steel tower test furnace rig. Suitable for high temperature and highly corrosive gases

FOR QUALITY CONTROL

Magnetic particle inspection
Mass spectrometer testing
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See Sweet's Catalog File and Chemical Engineering Catalog

Call or write for a consultation with a trained Koven representative and send for bulletin #550

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New Equipment . . .

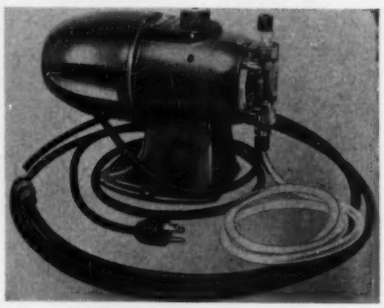
together for tight, positive shut-off.

Another feature, the steam-saving baffle, deflects live steam upward to envelop the bellows. This results in fast, snap-closed action and a greater degree of steam-saving efficiency. Literature available. W. H. Nicholson & Co.

Circle E21 green card, last page

Chemical Feed Pump Designed for Acid Service

A new electrically driven chemical pump, specifically designed for service with sulphuric acid is suitable for feeding practically any chemical solution in amounts up to about one gallon per hour, against pressures to 100 psi. The new "BACO" diaphragm



type pump offers good self-priming and air-purging characteristics, and has a simple, dial-adjustable feed rate control. Supplied with a single-phase, 60-cycle, 115-volt motor, this pump operates at a speed of 30 strokes per minute, and has a total weight of only eight pounds. Details are available. The Bird-Archer Co.

Circle E22 green card, last page

REFRACTORY HAYDITE

Makes Higher Heat Resistant Concrete

Haydite aggregate used with Lumnite cement produces refractory concrete suitable for sustained temperatures up to 1800-2000° F., which makes it excellent for tubular heaters, ducts, flues, stacks and catalytic crackers. Weighing from 30 to 40 per cent less than ordinary aggregate concrete, Haydite is exceedingly strong. It has excellent insulating properties and withstands pressures of up to 1130 pounds per square inch. Write today for free folder and complete information about Carter-Waters Refractory Haydite.

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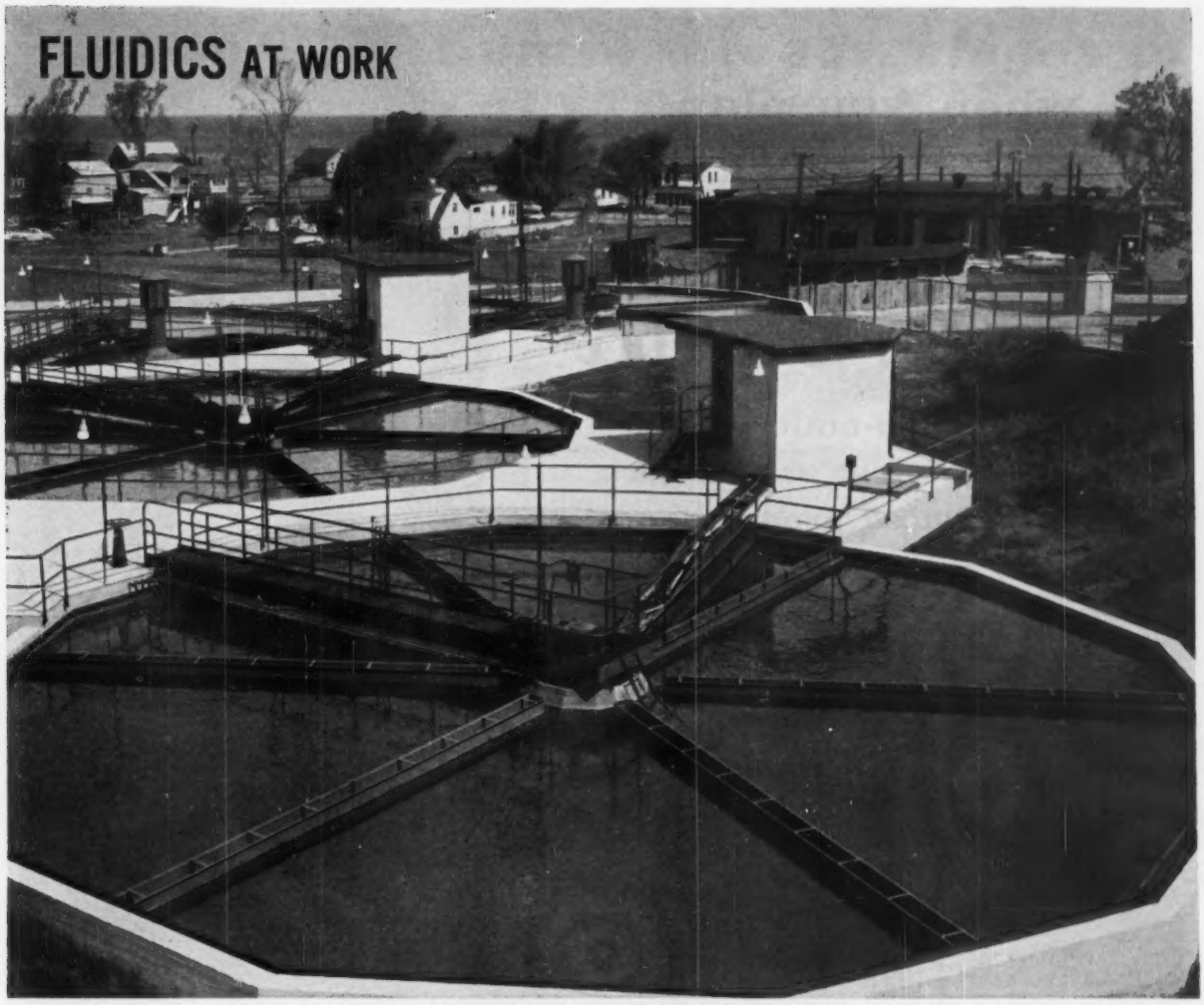

In the foreground is the newest of four Permutit Precipitators at Eastman Kodak's Lake Water Works on Lake Ontario near Rochester, N.Y.

HOW KODAK TURNS 24 MGD OF ITS LAKE WATER REQUIREMENTS INTO PURE WATER FOR CRITICAL USES

■ Row a mile and a half due north from this water plant. Dive 55 feet. You're at the intake end of Eastman Kodak Company's water system.

Travel six miles inland. You're at the Kodak Park Works, where the same water goes into critical manufacture of such quality products as photographic film, paper, and chemicals.

How this raw water, gulped from the lake in such great volume, quickly and economically turns into pure process water is the story behind our picture above.

Heart of the water system: precipitation

Kodak treats this water in three steps: (1) chemicals, (2) precipitation, (3) rapid sand filtration. The heart of the system is the removal of turbidity and color by precipitation, accomplished with four Permutit Precipitators.

One-hour detention time: savings in space, chemicals

Detention as short as one hour is possible with the Permutit Precipitator — as against two to four hours required in old-method lime treatment and coagulation plants. This higher throughput can save as much as 50% in space to handle a given volume of water.

Savings in chemicals and adsorbents can vary from 10% to 50%. Example: a given amount of coagulant removes more turbidity, color and algae in the Precipitator, because of the action of the suspended sludge in the mixing zone combined with the upward flow sludge filtration.

20-Page bulletin explains

Like Kodak, you may be faced with a need for big-volume, high-purity water. For full details on the Permutit Precipitator, write for our 20-page Bulletin 2204C. No obligation. Permutit Division, Dept. PR-71, Pfaudler Permutit Inc., 50 W. 44th St., New York 36, N.Y. (In Canada contact the Permutit Company of Canada, Toronto.)

PFAUDLER PERMUTIT INC.

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For more data on advertised products, use cards, last page.

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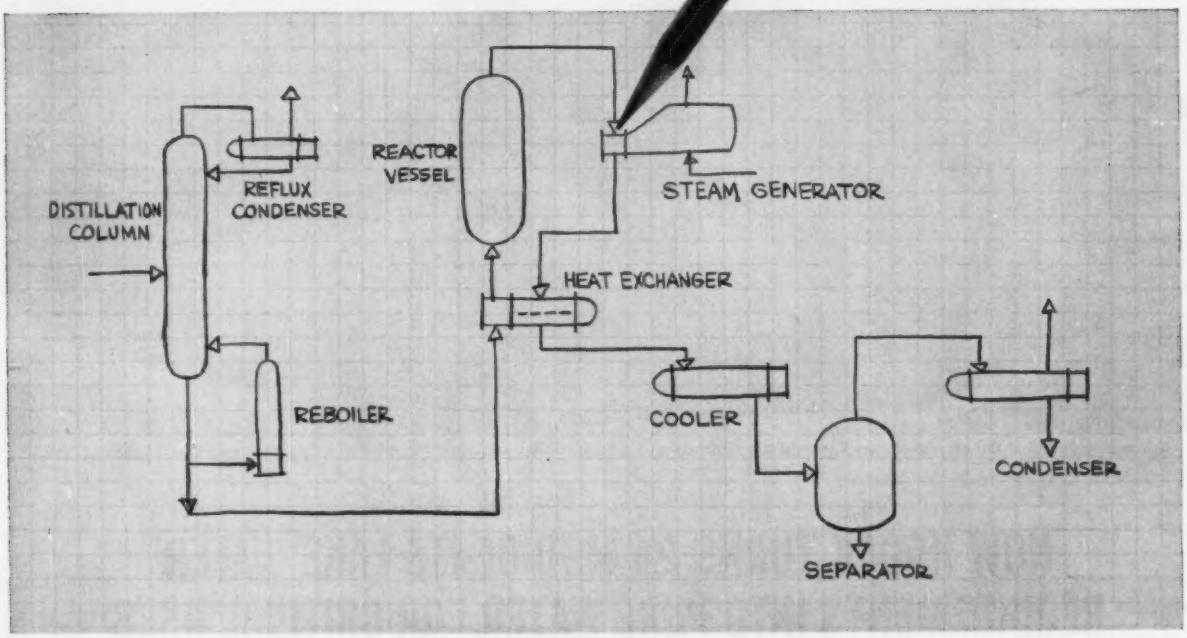
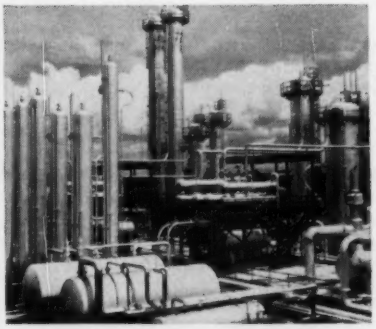
for custom-built pressure vessels, heat exchangers and related products



Plan on A. O. Smith for your process equipment—and plan with confidence. A. O. Smith has the facilities and know-how to custom-tailor process equipment to your exact specifications. A world-recognized leader in the process equipment field, A. O. Smith can provide quality-built components to satisfy any process requirement.

However, building modern process equipment is only part of the A. O. Smith plan. Also available to you is the industry's most respected staff of research scientists, technicians and engineers who will help you analyze your operating conditions and make suitable recommendations backed by long experience.



Many modern process plants have a complete range of A. O. Smith custom-built equipment, such as: heat exchangers • reboilers • evaporators • condensers • coolers • columns • hydraulic cylinders • air storage vessels • reactors • autoclaves • tanks.

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ATOMIC AND PROCESS EQUIPMENT DIVISION
Milwaukee 1, Wisconsin

operating data prove the advantages of BENDER CATALYTIC SWEETENING

In the chart below, the PETRECO* BENDER Process speaks for itself through operating results in the treatment of a variety of stocks in the gasoline, jet fuel, kerosine and burning oil range. The cost data particularly show a major advantage the Bender Process has over conventional sweetening methods. Chemical costs, including catalyst maintenance, average 0.5 cent per barrel. Installation costs are estimated at $15-$30 per barrel, per day of throughput.

Your nearby Petreco engineer is prepared to make recommendations. Contact him or write Petreco for a descriptive brochure, without obligation.

PETRECO* BENDER OPERATING DATA

Plant Location	Type of Stream	Charge Rate B.P.D.	RSH Cont. % By Wt.	Catalyst Towers No. & Size	Air Req'd. Std. Cu. Ft. /Bbl.	Sulfur Req'd. Theor. Equiv.	Caustic or PbO Sol. Req'd. #/M Bbls.	Man Hrs. /Day for Super.	Treating & Catalyst Reworking Costs ¢/Bbl.	Install. Cost Est. $/Bbl.	PbO Cont. Prod. ppm	Oxy. Cont. Spent Air %	Treating Temp. °F.	Treat-ment After Bender
1. Houston, Texas	Jet Fuel Kerosine	6,000 to 10,000	0.007 to 0.035	3–6′x20′	0.5	1.0 to 2.0	6 NaOH 0.8 PbO	4	4.5 years 0.5	20	2–4	—	130°	None
2. E. Chicago, Indiana	No. 1 Fuel Kerosine	4,500	0.007 to 0.01	3–6′x10′	1.0	1.6	10 NaOH 1.3 PbO	6	No Rework For 3 yrs. 0.25	10	1–3	—	130°–140°	Water Wash Only
3. E. Chicago, Indiana	No. 1 Fuel Kerosine	4,500	0.007 to 0.01	4–3′–6″x10′	1.0	1.6	10 NaOH 1.3 PbO	6	No Rework For 11 yrs. 0.20	10	1–3	—	130°–140°	Water Wash Only
4. Marcus Hook, Pa.	Kerosine	7,600 to 14,000	0.007 to 0.01	4–6′x25′	0.05	1.7	5–7 NaOH 0.7 PbO	4	28 months cat. life 0.70	15	4–6	0	130°	Clay Contact
5. Beaumont, Texas	Kerosine	20,000 to 25,000	0.015 to 0.09	3–10′x24′	0.35 to 1.9	1.25 to 2.0	5–25 NaOH	4-8	27 months cat. life 0.8	30	5-20	0–3	130°	Petreco Water Wash
6. Long Beach, Calif.	P.D. Gasoline	1,200 Charge 3,600 Recycle	0.045 to 0.09	2–4′–8″x18′	1.0 to 1.7	1.2 to 1.4	18 NaOH 0.5 PbO	6	26 months cat. life 0.65	16	10–20	0	85°–90°	None
7. Norwalk, Calif.	S.R. Gasoline	4,000	0.006	2–5′x22′	1.0	1.0	2–10 NaOH	4	Reworked After 18 mos. 0.5	20	2–5	0	85°–105°	None
8. Norwalk, Calif.	Jet Fuel P.D. Gasoline	2,500	0.007 to 0.02	2–4′x22′	0.2 to 1.0	1.0 to 2.0	2–10 NaOH	4	No Rework for 3 yrs. 0.5	20	2–5	0	85°–110°	Acid Treat Jet Fuel None on P.D.
9. Linden, N. J.	S.R. Gasoline	1,200	0.0016 to 0.002	3–3′x16′	0.05	1.0	2–10 NaOH	3	No Rework for 20 mos. 0.5	30	1–3	0	85°–100°	Water Wash Only
10. Bronte, Ont.	No. 1 Fuel	3,420	0.005	2–5′x20′	0.3	1.8	2–10 NaOH	6	No Rework for 18 mos. 0.5	30	1–3	0	120°–130°	Petreco Water Wash
11. Odessa, Tex.	Jet Fuel	1,111 to 1,700	0.002	2–30″x22′	0.2	1.5	3 NaOH	3	No Rework for 18 mos. 0.5	30	1–5	0	110°–120°	None
12. Wilshire, Calif.	Stove Oil & Jet Fuel	4,800 to 6,300	0.0032 to 0.005	3–6′x20′	0.88	1.0 to 1.8	10–15 NaOH	4	No Rework for 24 mos. 0.5	20	2–5	0	110°–120°	Acid-Alkali By Petreco
13. Calgary, Canada	No. 2 Fuel	1,600 Recycle 1,600	0.069	2–4′x18′	2.0 to 3.0	1.5	20 NaOH	3	No Rework for 18 mos. 0.5	20	2–5	0	130°–160°	Water Wash Only

*Registered trademark, Petrolite Corporation

B-61-1

PETROLITE CORPORATION

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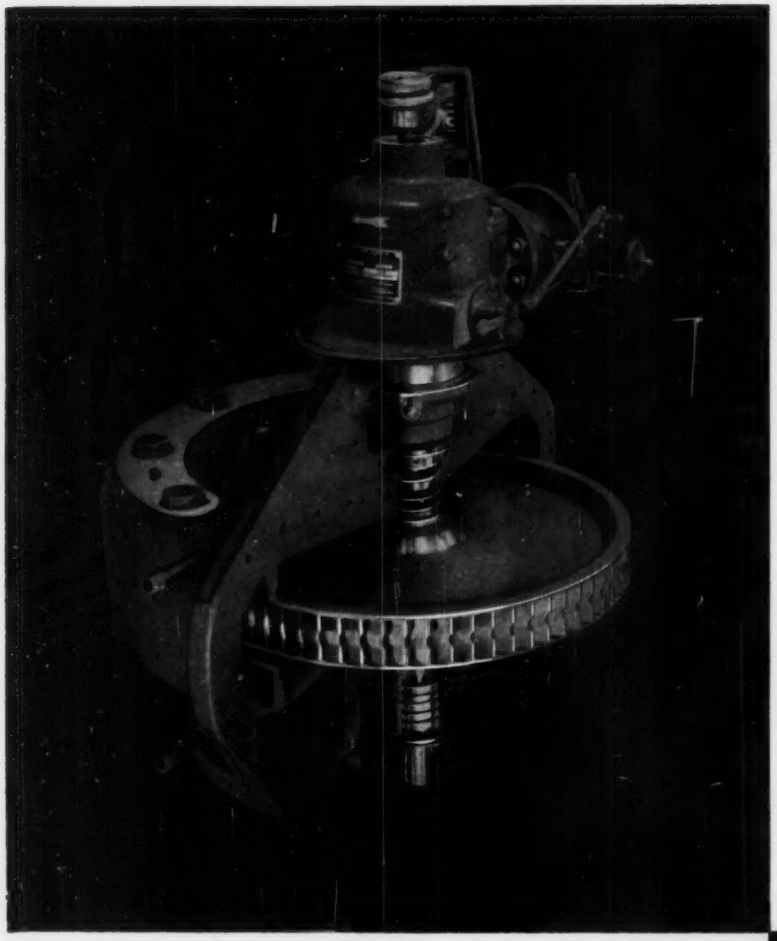
Here's a vertical turbine with

TERRY SOLID WHEEL

and all its advantages



When it comes to judging a turbine's ability to deliver in vertical service, ratings tell only half the story. It's the Terry construction refinements that give you assurance of long-range operational economy: Thrust bearing designed to absorb external pump thrusts ... carbon ring glands specially made for vertical operation ... casings and bearing housings split vertically for easy accessibility.

But most important, the Terry vertical turbine has an *almost* indestructible rotor. A single forging of special composition steel, it has no separate parts to loosen or work out. As the only function of the blades is to form a series of pockets, any wear which might occur would not materially affect horsepower or efficiency.

If your application demands a vertical turbine, specify Terry solid wheel. Available in capacities from 5 to 300 horsepower. And remember, the extra durability built into these vertical turbines is typical of every turbine in the complete Terry line.

For further information, send for a copy of bulletin S-137.

THE TERRY STEAM TURBINE CO.
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TERRY

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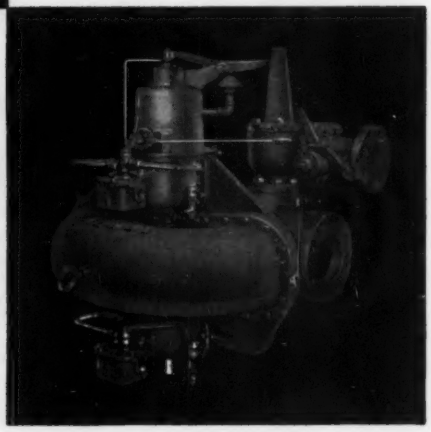


Du Pont *Petroleum Chemicals* News

Number 109 in a series of bulletins for the Petroleum Industry JULY • AUGUST 1961

TWO MOVIES BARNSTORM THE COUNTRY

Oil companies tie in, to expand the demand

Now touring the country is "Down the Road," the CinemaScope featurette which co-stars the roads of America and the rich heritage they lead to.

Sponsored by Du Pont as part of the oil industry's travel-promotion program, this film is being met with applause by audiences everywhere.

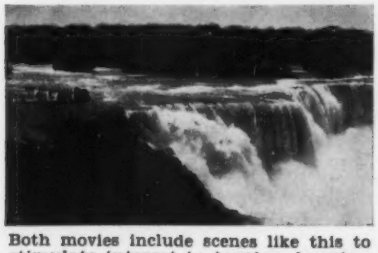
In many localities, oil marketers have tied in with local showings.

For example, in Albany, N. Y., service stations throughout the area blossomed forth with colorful posters promoting the movie. Efforts of several oil companies were carefully coordinated for this promotion by the Du Pont representative, who supplied the posters.

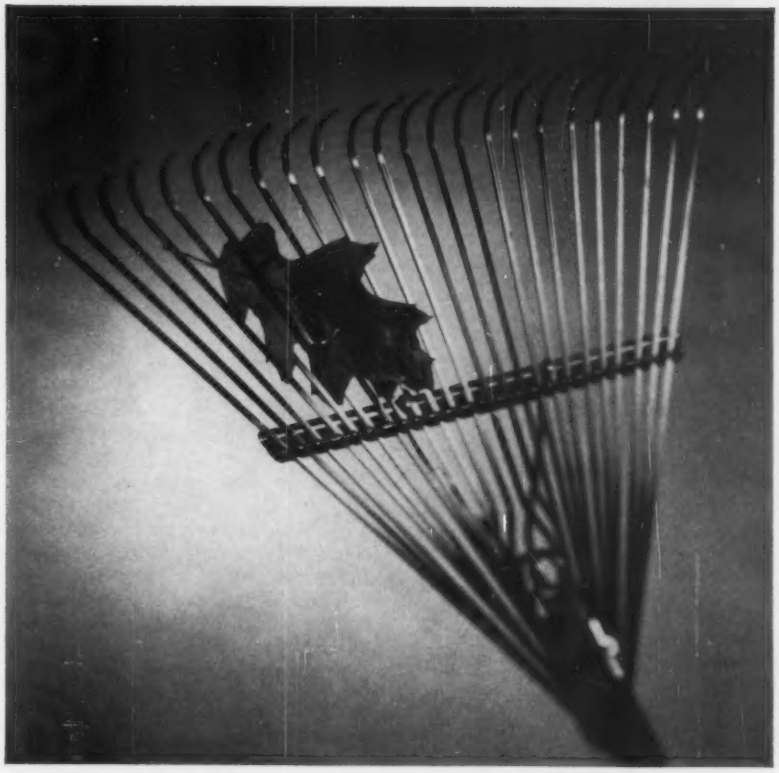
Your Du Pont representative can give you the playdates in your marketing area, if you are interested in running a similar promotion.

Also available is the 16-mm color movie, "Highway Holiday," a half-hour film which picks up the open-road theme of "Down the Road" and expands upon it. A number of oil companies are now using it as a part of their own travel-promotion programs.

Your Du Pont representative can arrange a showing of "Highway Holiday" for you, as well as supplying prints for showing to dealer meetings, civic groups, clubs, etc.



Both movies include scenes like this to stimulate interest in touring America.



How to sell a better fuel oil in the heating season ahead

Sometime between now and Labor Day, it can pay you to give a little extra attention to the stability of your fuel oil.

Sludge can be the source of many oil heater problems, customer complaints and loss of business. It clogs filters, plugs burner nozzles. It reduces capacity of your storage tanks (and your customers'), often creates an expensive cleanup problem.

But you can solve the sludge problem *before the heating season begins*, by adding a small quantity of Du Pont Fuel Oil Additive No. 2 to your fuel oil. Usually just 5 to 15 pounds of FOA-2 are enough to prevent sludging in 1,000 barrels of oil. Your costs are low.

FOA-2 is a solubilizer and dispersant. It prevents sludge accumulation, and can even disperse previously formed sludge.

It is a non-metallic additive. It burns completely along with the fuel, leaving no ash of its own.

Refiners have stabilized millions of barrels of heating and fuel oils with FOA-2 since its introduction ten years ago. It continues to be one of the most profitable decisions you can make to safeguard the quality of your product.

Your Du Pont Petroleum Chemicals representative has the information you need to clear up the sludge problem *before* the fall heating season sets in.

ADVERTISEMENT—Prepared for the Petroleum Chemicals Division of E. I. du Pont de Nemours & Company (Inc.)

OVER ▶

Du Pont *Petroleum Chemicals* News

MID-CONTINENT TECHNICAL MANAGER

CHARLES B. MILLER is Technical Manager of the Du Pont Petroleum Chemicals Division, Mid - Continent Region, headquartered in Tulsa, Oklahoma.

Mr. Miller joined Du Pont in 1941 and was first assigned to Jackson Laboratory, one of Du Pont's basic research laboratories. He has been with the Petroleum Chemicals Division since 1952. Prior to his present assignment, he held the position of Mid-Continent Regional Laboratory Manager in Tulsa and Research Chemist at the main Petroleum Laboratory located at Carneys Point, New Jersey.

Mr. Miller and his laboratory staff make available to the oil industry the expanding technical services of Du Pont. Gasoline antiknocks and additives for petroleum products are his specialty. Wide experience in the laboratory and in the field enables him to assist refiners in the selection of the proper additive product to do a job.

Mr. Miller holds a Masters degree in Chemistry from the University of Delaware.

What's the score on motorists' buying habits?

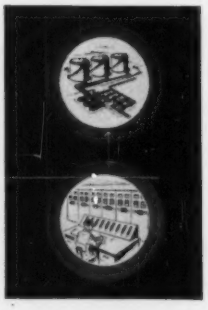
The "Summary Report" of the Du Pont "Profile of the Motorist" survey is now available. This 40-page booklet contains a concise report of the results of the most extensive survey ever made of the American motoring public.

The new publication contains the survey's answers to questions such as how people react to price-wars, give-aways, trading stamps, regular vs. premium gasolines, TBA purchases, credit cards, vacation driving — and many other findings which explain the motorist and the market he represents.

The "Profile" survey is the fourth in the Du Pont series dealing with service station marketing. The "Summary Report" contains comparisons with the earlier surveys, to give marketing groups a picture of the trends in several areas of inquiry.

Your Petroleum Chemicals Division representative will be pleased to provide you with a copy of this new publication.

New developments in continuous gasoline blending discussed in talk



The advent of electronics has dramatically changed the position of in-line blending in the oil industry.

Until recently, most refineries had to make so many changes in field piping that they could not justify the expense.

It is no longer necessary to make such extensive field piping changes. With electronic control equipment and transmission of signals as digital pulses, gasoline components no longer need be piped to a central meter station adjacent to a control room.

Not only are piping costs much lower, but there are also new savings in the size, location and installation costs of the control room and control equipment.

B. G. Crane, Manager of Operations in Du Pont's Petroleum Chemicals Division, spoke on new in-line blending developments at the annual meeting of the W.P.R.A. If you would like a transcript of Mr. Crane's talk, contact your Du Pont representative.

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... through Chemistry

Du Pont Lead Antiknock Compounds and other Petroleum Additives

OVER

ADVERTISEMENT—Prepared for the Petroleum Chemicals Division of E. I. du Pont de Nemours & Company (Inc.)

Serial A-20427 117326

Printed in U.S.A.

1800 EXPANSION JOINTS
OF STAINLESS STEEL

Air Force Titan missile bases require many miles of stainless steel LOX piping. To protect these piping complexes from thermal changes and shock conditions, special stainless steel expansion joints —1800 of them—were required.

Adsco built these special expansion joints, taking them carefully through design, forming, welding, and assembly. The expansion joints were cycle-tested with liquid nitrogen at -297° F. and cleaned. The Corps of Engineers inspected each one under black light and each joint was hermetically-sealed. System cleanliness limits were 25 parts per million —150 micron particles.

Knowledge and experience such as this could be of help to you in your expansion joint work. Call on Adsco!

ADSCO DIVISION
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YUBA

YUBA CONSOLIDATED INDUSTRIES, INC.

ONE OF A SERIES OF CHATS ABOUT THE CONSERVATION AND CONTROL OF HEAT

SARCO TOPICS

DOWNTIME DOWN —OUTPUT UP

Continuous processing . . . two big words in the world of petroleum processing . . . and one big headache when the line has to shut down unexpectedly. It's not just the pure pain in the neck that mechanical failure produces. It's the costs that keep mounting during downtime.

Let's face it, no one can eliminate every bug. But steam trap failure is a bug there's no excuse for. Not since Sarco created the Thermo-Dynamic Steam Trap, Type TD-50.

For one thing, TD-50's hardly know the meaning of the word downtime. For another, maintenance people like them for their ease of inspection and service. And TD-50's don't require high quality steam to function. Reichhold Chemical's new Maleic Anhydride plant in Elizabeth, New Jersey, for example, has standardized on TD-50's, for these very reasons. Of their 320 TD-50's, most are in service on 35-lb. steam tracer lines.

How come it's so trouble-free? Because it's simple, with only one moving part. Its performance is uniform; it operates equally well on heavy, light, or no condensate load—even against back pressures up to 50% of inlet pressure. It's so rugged that superheat, water hammer, vibration, or corrosive condensate won't affect it. If you should ever want to service a TD-50, a highly unlikely prospect, you can unscrew the cap, clean it, blow it down, and have it back on stream in 40 seconds.

You ask how it works? Aha! That's another story that goes back over 200 years, and what better place to tell it than right here, in the section that follows.

The character pretending to inspect one of Reichhold's TD-50's is Sarco's ad manager, who normally wears a gray flannel suit. We're happy to see strainers used properly on this 14-trap manifold to protect the steam traps, even if they don't happen to be Sarco strainers.

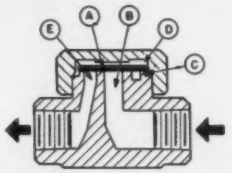
MR. BERNOULLI HELPS BUILD A BETTER STEAM TRAP

We may be a trifle tardy in bringing it up, but Daniel Bernoulli, who dreamed up the "Bernoulli Effect" about 250 years ago, deserves some sort of accolade from us here at Sarco. A plaque perhaps, or his name in the foyer floor tile. Daniel was a famous Swiss mathematical genius and he was probably a little hesitant about even mentioning his slightly offbeat discovery, the "Effect," in *Hydrodynamica* (1738).

If you happen to have a spool handy, you can perform the simple "effect" right at your desk. Lay a cardboard disc with a pin through it on the table. Place the spool over the pin and blow—hard—and lift. The disc won't fall until you stop blowing because the air under pressure expands between the end of the spool and the disc. The pressure in this space is actually less than atmospheric, and the sum of the downward forces is less than the upward force of atmospheric pressure acting upon the disc's bottom side.

Well, of course it *sounds* rather remote, but what seemed like a simple parlor trick to Bernoulli has made it possible for us at Sarco to solve steam trapping problems by the dozens. In our Sarco Thermo-Dynamic Steam Trap, Type TD-50, the cardboard disc is replaced by a stainless steel disc A, the spool tube by inlet tube B. The disc also acts as a valve and can seat on B, and also on outer seat ring C. When seated, the disc seals the inlet and the chamber D from the outlet E.

Full attention now, because it could easily be *your* steam, condensate, or air we're following here as it enters the trap, its pressure raising the disc and allowing fluid to flow radially across the underside of the disc. The velocity of air or condensate is comparatively low, exerting little influence on the disc, which remains



clear of the seat, allowing free discharge. Ah, but now steam enters the trap. Velocity increases greatly because of the steam's greater internal energy. Presto! The disc is pulled toward the seat just as was the cardboard. At the same time, the radial steam jet raises the pressure in D by recompression, snapping the disc down on the seat.

Downward force of recompressed steam in D, acting on the full area of the disc, is greater than the upward force of the inlet steam acting on the smaller area of the inlet orifice. So the disc remains seated, stopping all flow of steam, until pressure in D is reduced by condensation, and the cycle is repeated.

BEYOND THE TD-50 PRINCIPLE

Surprise! In spite of the one-track subject matter you've had the decency to ingest so far, we manufacture a good deal more than TD-50's. As a matter of proud fact, we are the only company that makes and sells all five types of steam traps. After all, there is a place for Balanced Pressure Thermostatic, Float Thermostatic, Camlift Bucket, and Liquid Expansion Thermostatic Steam Traps too. And our knowledgeable engineers can tell you exactly where to use what—and how.

And may we modestly add, that's only the beginning? As long as our present conversation seems to consist of product name dropping, we'll just mention the fact that we make exceptionally fine pressure and temperature regulators of rather astonishing variety and ingenuity. For example, we have a complete line of self-powered regulators for heating and cooling. And to make most effective use of these last few lines—strainers of all kinds—even hand and motor operated scraper strainer types. We could fill this page with lists of applications, testimonials, and specifications, but it would be eminently more sensible simply to say: Tell us your problem.

Write us direct, or contact your local Sarco sales representative or sales office.

Pardon our monopolizing the conversation in this series of paid communiques, but we're trying our best to interest you in certain subjects that concern us both—to the point where you'll communicate. 6816

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PLANT: BETHLEHEM, PA.

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Here's what grows in your cooling towers

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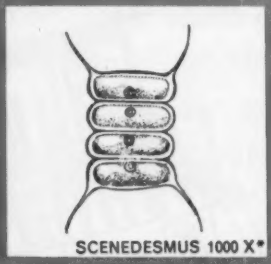
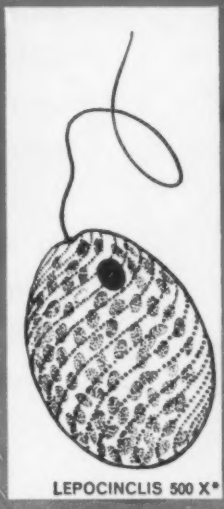
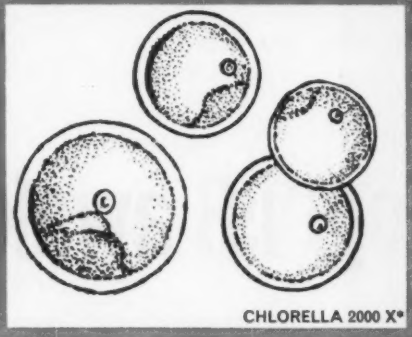
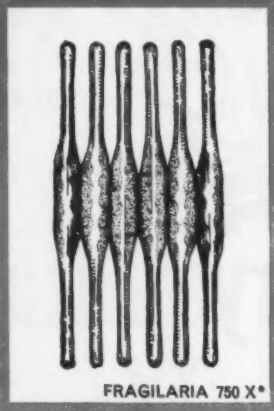

SCENEDESMUS 1000 X*

MELOSIRA 1000 X*


LEPOCINCLIS 500 X*


CHLOROLLA 2000 X*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Dearcide® kills them!

An ideal environment exists in open, recirculating cooling systems for the growth of algae and other microbiological organisms of many types. These often reduce efficiency of cooling towers, heat exchangers, and circulating systems . . . can lead to serious corrosion of cooling system components and deterioration of cooling tower wood. ■ Chlorine in various forms or combinations has, in the past, been a major combative agent in general use in spite of certain objectionable characteristics. ■ Now, Dearcides—products of Dearborn research laboratories—provide more effective control without introducing problems of corrosion, toxicity, and high maintenance costs. Dearcides are non-corrosive . . . will not attack cooling system components . . . have no deleterious effect on wooden cooling towers . . . are compatible with commonly used water treatment chemicals . . . require no feeding equipment. Most have extremely low toxicity to fish and animal life . . . may be used when cooling tower blow-down water is discharged directly into streams or lakes.

MAIL THIS COUPON TODAY

SEND FOR THE REPORT of a two-year study of algae in cooling towers in all parts of the country, made by Dearborn Microbiologist Edward Tehle, Jr. It contains technical information pertinent to your plant wherever it may be located. It's free. It's interesting. It's a valuable reference piece for your water treatment library. Send for it today.

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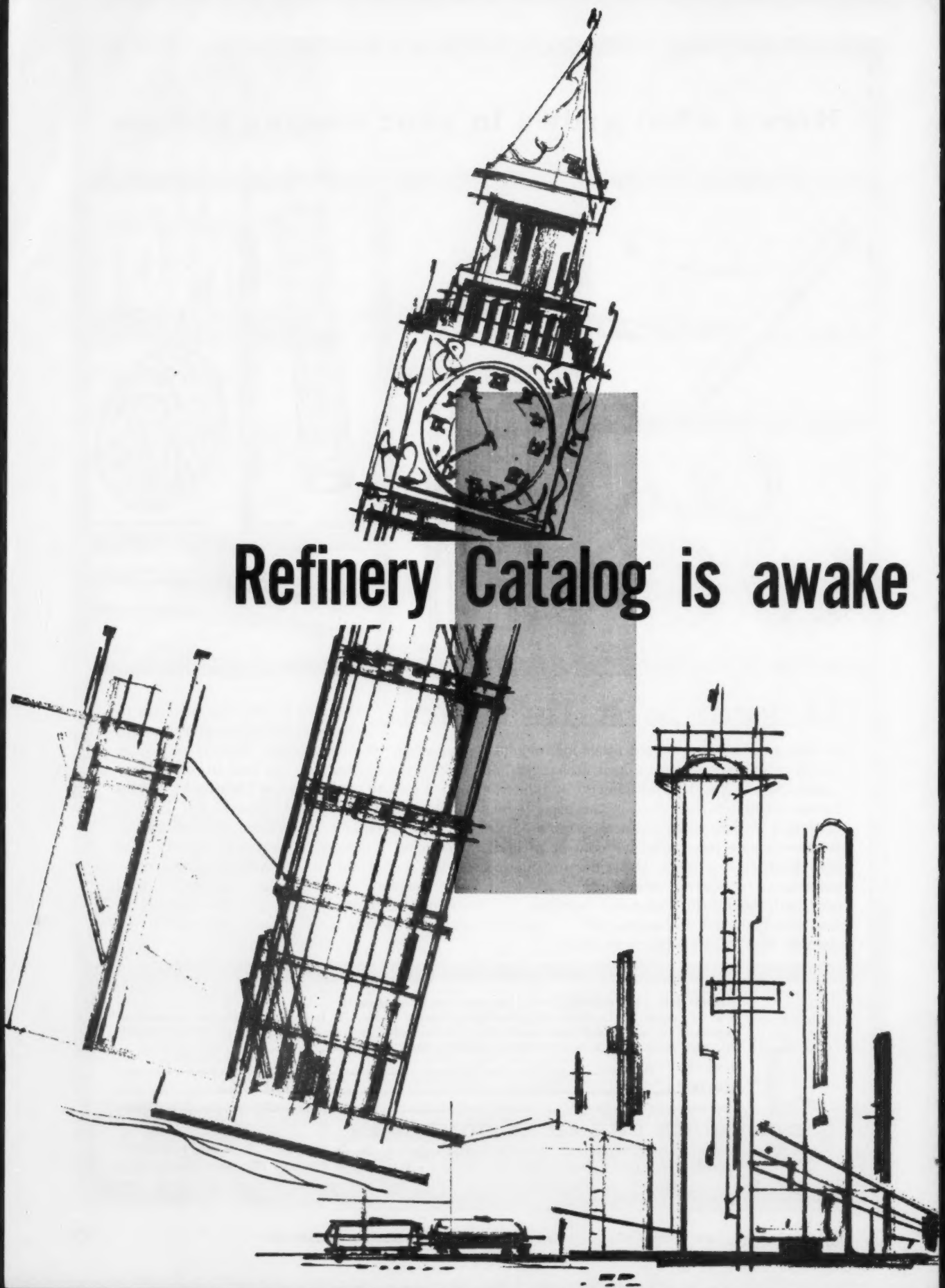
For more data on advertised products, use cards, last page.



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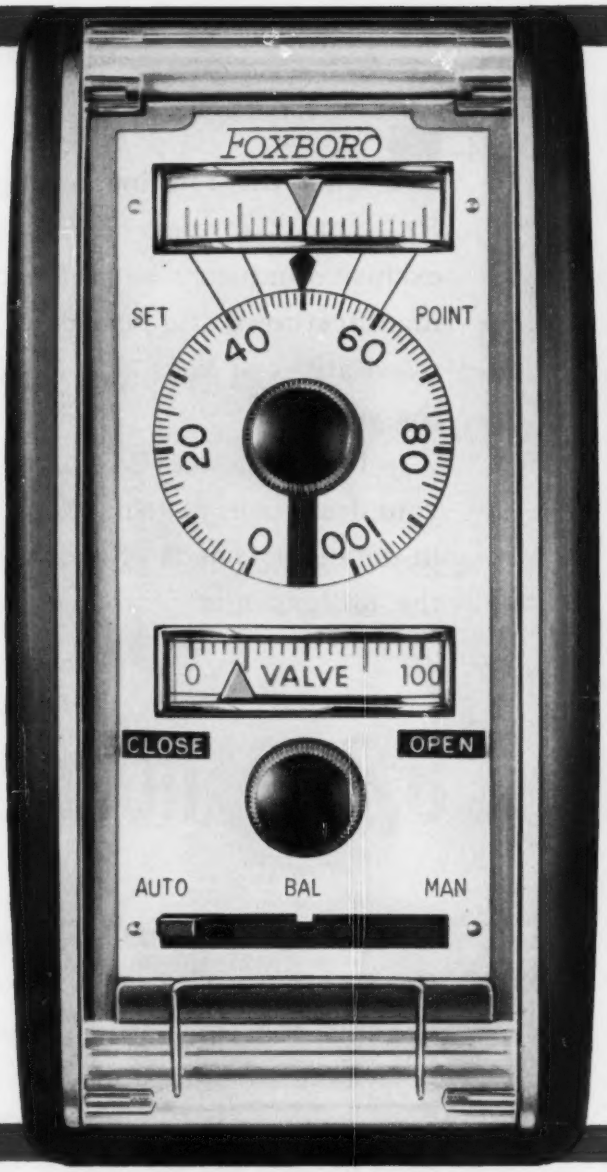

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One 3″ x 6″ panel station containing all control and supervisory functions — that's the Foxboro Electronic Consotrol* Controller. All d-c input — all d-c output — all solid state. Operates completely independent from recording.

And look at these other features:

- measurement and deviation indicator gives continuous indication of process measurement as well as showing the deviation from set point.
- calibrated set point dial, with 4¾″ scale, used with deviation indicator for readability of ½% full scale.
- valve position indicator for continuous, horizontal-scale indication of valve opening.
- simple auto-manual transfer switch for smooth, bumpless transfer.

Foxboro electronic Consotrol control stations are available for cascade, ratio and auto-selector systems. Ask your Foxboro Field Engineer about them — or write for Bulletin 21-10. The Foxboro Company, 747 Neponset Avenue, Foxboro, Massachusetts.

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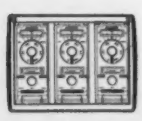
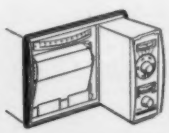
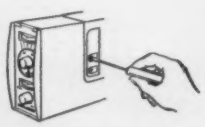


Standard 9″ x 6″ housing holds 3 control stations, or 1 station with a companion recorder.



Controller and recorder each slide out from panel for easy servicing.



Proportional — reset — derivative: all adjusted from the front.

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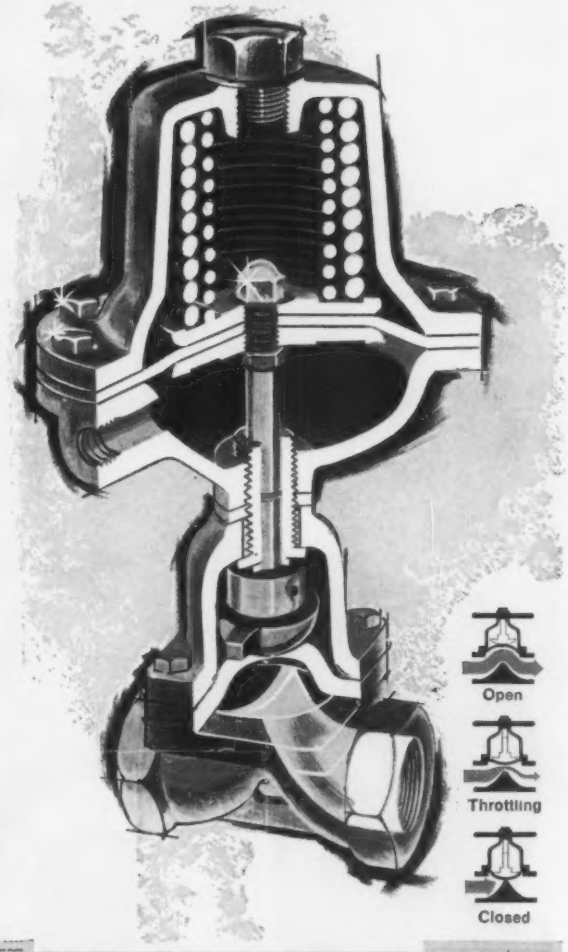
You can see the sense to HILLS-McCANNA Air-Operated Diaphragm Valve Design



Here is *economy...simplicity...reliability...accuracy* for automatic and remote flow control service.

- WIDE RANGE OF OPERATOR SIZES—no need to buy more operator than needed for a given size valve.
- DRIPTIGHT SHUTOFF—will close tightly even against solid particles on seat.
- ACCURATELY CONTROLLED THROTTLING—valves available with tell-tale travel stops, limit stops, and positioning devices for consistently repeatable control accuracy.
- TYPES FOR EVERY JOB—air open—air close, air open—spring close, and spring open—air close types.
- WORKING PARTS completely isolated from flow.
- BODY AND DIAPHRAGM MATERIALS to handle paper pulp, acids, alkalies, oils, foods, beverages, fats, slurries, semi-solids, viscous materials, compressed air, gases, volatiles, atomic reactor wastes, fuels, and hundreds of other fluids.
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DV61-1

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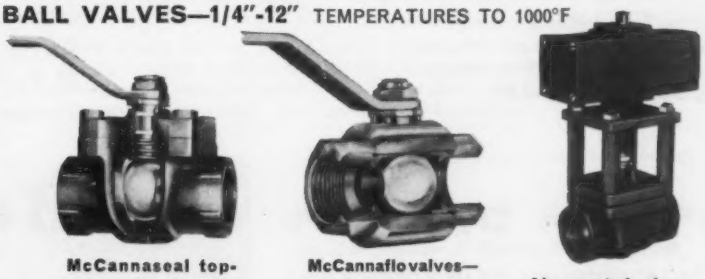

McCannaseal top-entry valves for easy in-line maintenance.

McCannaflo valves—simple, compact, economical.

Air-operated valves—in all types and sizes.

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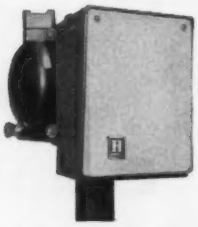
gives you field indication plus convenience and precision



You get all the economy and convenience of pneumatic transmission and all the efficiency of the bellows meter body plus field indication, when needed, in the new Honeywell Bellows Flow Transmitter. Use it in any application to transmit flow or liquid level measurements in open or closed tanks.

This new meter has automatic ambient temperature compensation and two-way overload protection for 100% of span. Maintenance is greatly simplified by modular construction which lets you remove any major component by loosening two screws. All field adjustments are easily accessible, and a self-locking feature prevents upset after calibration adjustments are made.

You can change ranges in the field simply by removing a single spring assembly and replacing it with an assembly of the desired range . . . adjust damping quickly and accurately, while the instrument is in operation . . . install the meter with either vertical or horizontal piping, so that it vents, drains and purges itself. The meter transmits with calibrated accuracy of ±0.5% of full scale, and indicates within ±1.0% of full scale.

New Bellows Transmitter is available with a concentric scale or as a non-indicator. It has 16 ranges—from 0-10 inches of water to 0-400 inches of water.

For complete details on the new Bellows Flow Transmitter, call your nearby Honeywell field engineer. Or write MINNEAPOLIS-HONEYWELL, Wayne and Windrim Avenues, Philadelphia 44, Pa.—In Canada, Honeywell Controls, Ltd., Toronto 17, Ontario.

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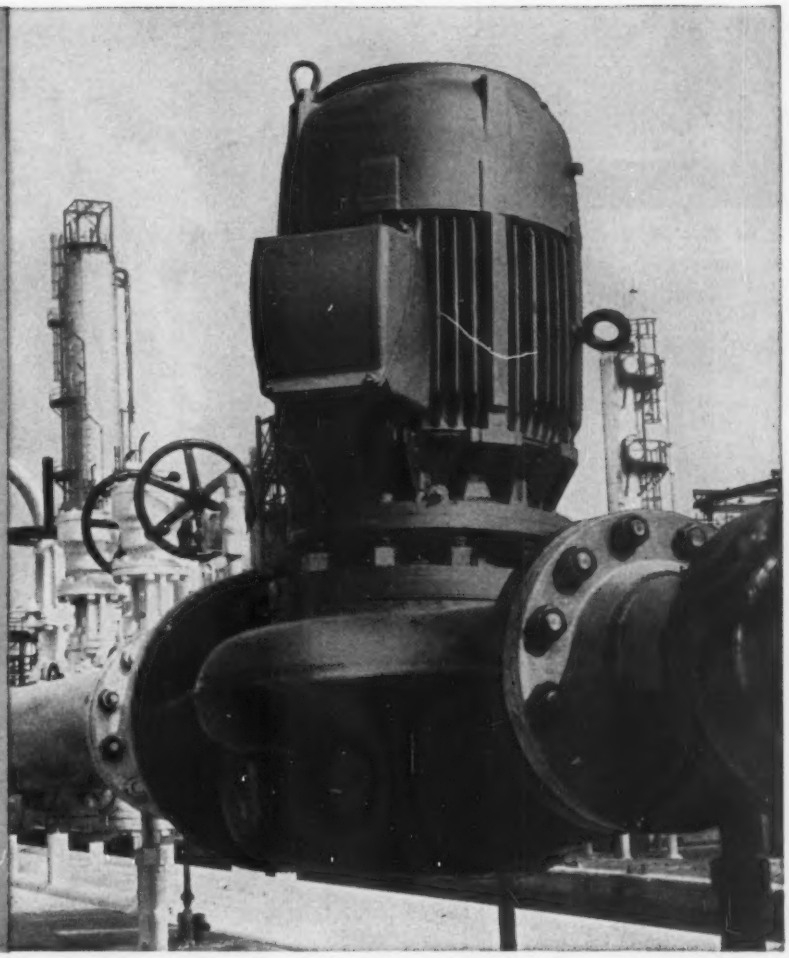

ECONOMIC BALANCE—an optimum relationship between capital and continuing costs of equipment is especially true in process pumps, whose lifetime operating and maintenance costs may be many times the initial investment.

Here are the factors of best economic balance in process pumping offered by Pacific's new pipe-mounted centrifugal pumps:

LOWER FIRST COST: Fewer (only six functional) parts • No separate pump bearings or brackets • High degree of interchangeability—minimum inventory.

LOWER INSTALLATION COST: No baseplate or foundation required • No field alignment necessary • Integral drive—no motor coupling • Flange-mount and connect to power—that's all.

LOWER MAINTENANCE COST: Standardization of seals and shaft-mounted parts • Ready access, even in closest quarters, for field service, *or* • Easily demounted as a unit for shop maintenance.

LOWER OPERATING COST: Each pump impeller designed for peak efficiency in a given application, *or* • Where low power costs permit, orifice control can be provided to adapt one pump size to a wide variety of applications.

There is only one *true* cost of a process pump. It's the *overall*, lifetime cost of the unit. Make a date with your Pacific Pump representative to discuss the entire pump standardization plan in your plant. He has the broadest line of any in the process field... and the experience to match.

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CP-25

LUMMUS

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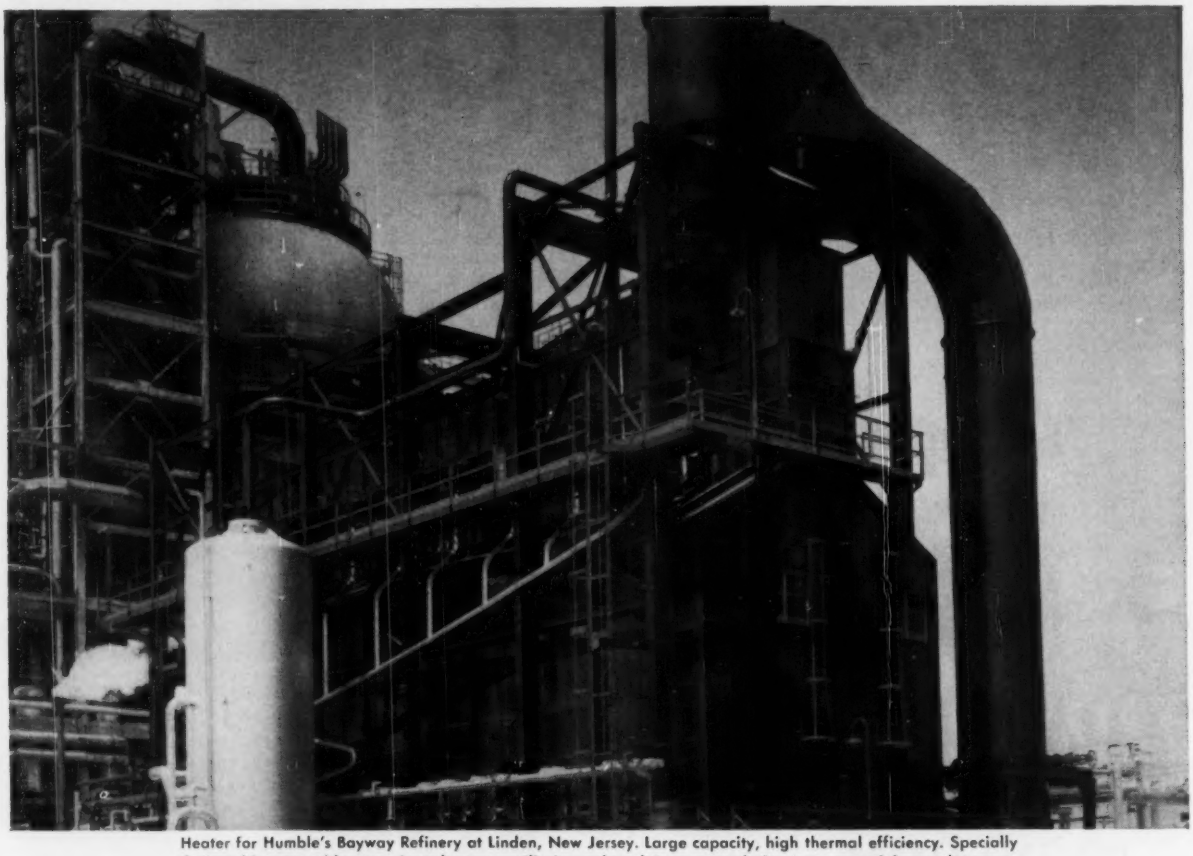

Heater for Humble's Bayway Refinery at Linden, New Jersey. Large capacity, high thermal efficiency. Specially designed integrated heater, air preheater, auxiliaries and stack in compact design to occupy minimum plot space.

Lummus Oil Heater for Humble's Bayway Refinery meets three tough design requirements

LARGE CAPACITY, HIGH EFFICIENCY, LONG RUNS

Humble Bayway knew exactly what they wanted in a replacement heater and turned confidently to Lummus to meet their difficult design requirements.

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Secondly, Humble wanted a high thermal efficiency, 86% as compared with the usual 75-80%. In the Lummus design, the heater utilizes Ljungstrom Air Preheater and integrated blower and duct system to attain high thermal efficiency. Operating performance has been consistently high. Humble's big fuel savings have more than made up for the slightly higher capital investment for air preheat equipment.

Finally, there was one other difficult design condition. The new heater would be required to operate for long periods without shutting down for maintenance or cleaning. The Lummus design included steam soot blowers which have kept both the bare tubes and studded tube in the convection section clean. The heater fires on heavy residual fuel oil having a very high solids content.

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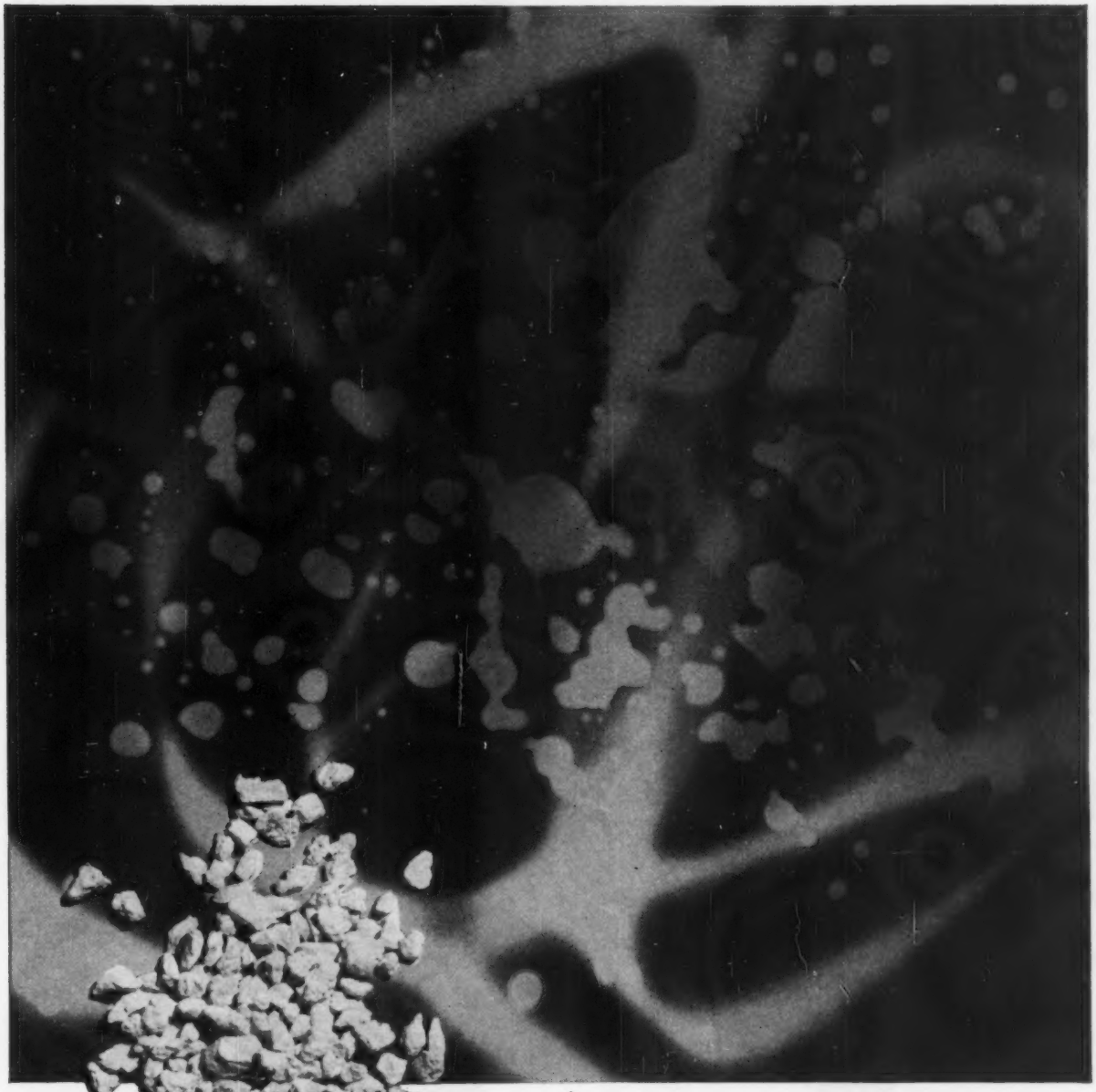
THE LUMMUS COMPANY, Oil Heater Division, 385 Madison Avenue, New York 17, New York, Houston, Washington, D. C., Montreal, London, Paris, The Hague, Madrid; Newark, N. J.



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and dry gases, liquids, vapors or solids drier than ever before! Mix imagination and engineering with *Alcoa® Activated Alumina* in your drying operation; this "old reliable" among commercial desiccants has been thoroughly proved in service. Count on it to achieve the lowest dew points you require. Drying costs are remarkably low because Alcoa Activated Alumina can be saturated and reactivated indefinitely without effective loss of drying capacity. If *you* have a dehydration problem and you haven't tried Alcoa Activated Alumina, you should—at *once*. For full information and samples contact the local Alcoa Sales Office or write ALUMINUM COMPANY OF AMERICA, CHEMICALS DIVISION, 707-G Alcoa Building, Pittsburgh 19, Pa.

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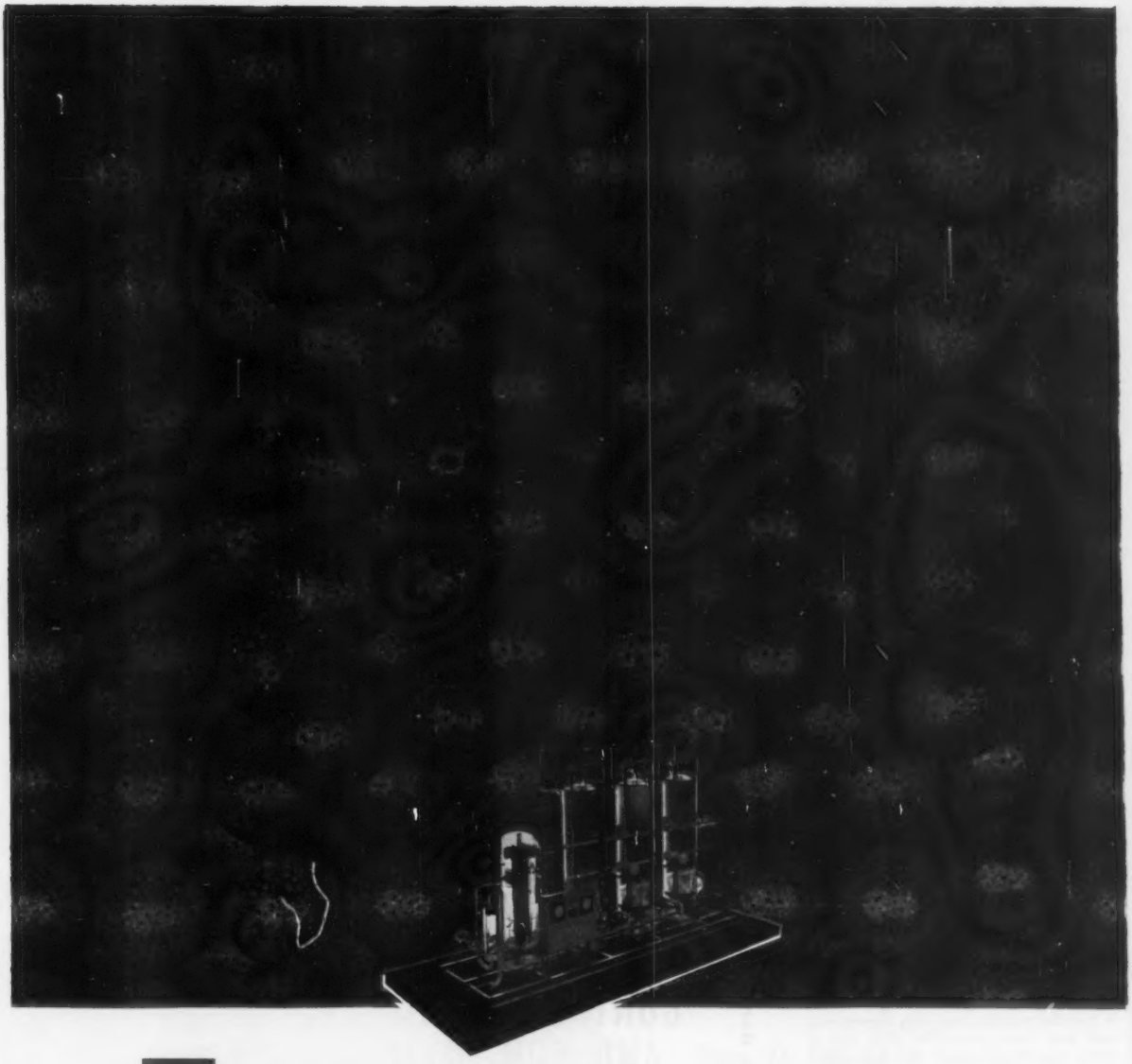

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Popular thinking on any subject is often like a pendulum, swinging forward in sheer exhilaration over an exciting idea, then backward to a cynical attitude against it. Years ago, health columnists extolled the nutritive qualities of spinach. Shortly thereafter, it was equally popular to decry spinach as an over-glamorized weed.

This vacillation springs from the efforts of spokesmen to capture interest, and the tendency of many people, like wild creatures in the forest, to give attention to whatever is moving regardless of the direction. That is why it sometimes seems that the more preposterous an idea the more credence it receives.

After World War II, supervisor and management development became extremely popular. Some of these programs naturally fell short of expectations, and there are always detractors — ready to display their intellectual brilliance by speaking cynically of *all* types of human relations training. Real progress in supervisory methods has, therefore, been slow.

Supervisory personnel, continually aware of the intrinsic values of human relations, are the key to uninterrupted production, completion of projects successfully and on time, for they forge the links in the productive chain solidly together.

Your management is interested not only in the creative, bold steps you would take into unknown solutions to problems, but also in how quickly and productively (profitably) you can put these ideas into practical application. When the solution, or idea, leaves your desk and starts down the long line of being put into practice, the supervisors throughout that chain of action will determine to a great extent whether their individual components will function properly or whether a project will bog down under the weight of misunderstanding and apathy.

It is extremely important, therefore, to maintain good supervisory practices throughout the various departments through which the original concept must be translated. It means a thorough understanding of human relations yourself, and the ability to communicate this understanding and appreciation to the supervisory personnel under you. This can and probably must be done both by individual contact with your supervisors and/or by conducting actual courses of study on the subject.

FOOTNOTE: the foregoing paragraphs are a direct quotation from another of Western's "personal-professional development" series. Booklet E-7, titled "Supervision — for Professional Advancement" a copy of which is yours upon request, without obligation. Write to WESTERN SUPPLY COMPANY, HEAT EXCHANGER DIVISION, P. O. Box 1888, Tulsa, Okla. — **where supervision contributes greatly to the manufacture of heat exchangers of the highest quality, and where personal attention to detail is our watchword.**

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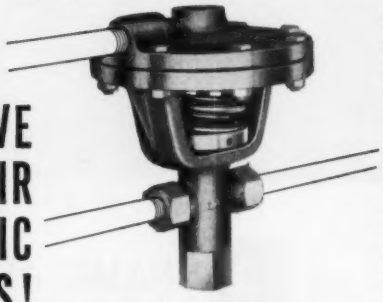

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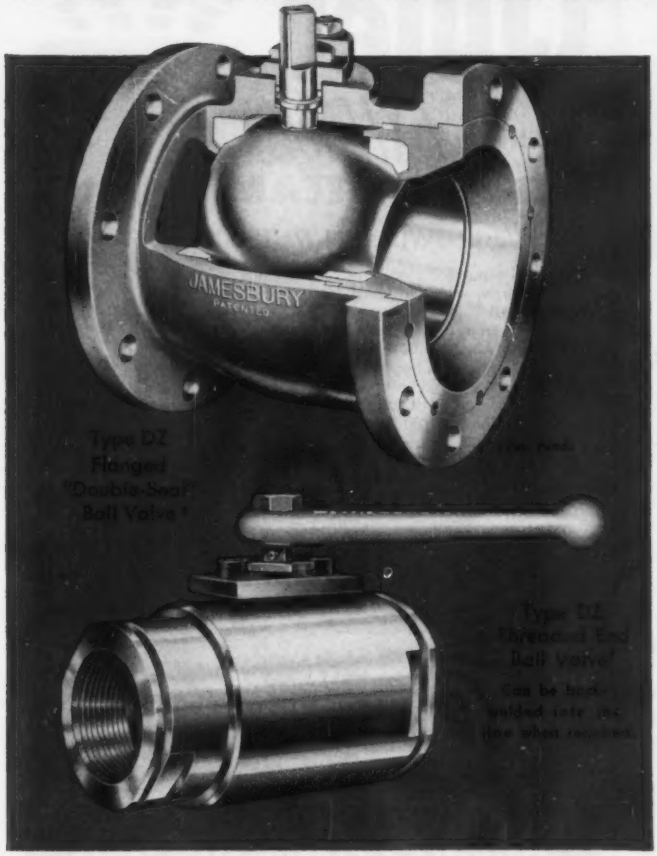

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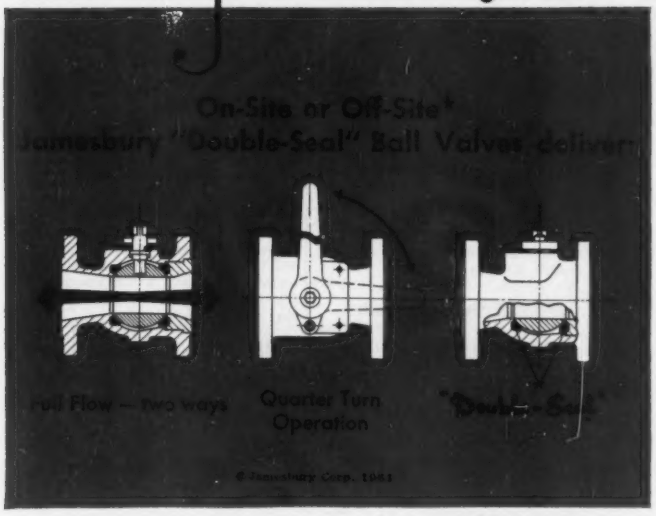
Now in use in refineries, petrochemical and natural gasoline plants in on-site hydrocarbon service at temperatures below 450°F.

HOW THE jamesbury FIRE*SAFE BALL VALVE OPERATES



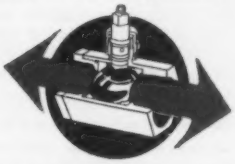
In the event of the loss of primary soft seats, a secondary metal seat provides completely effective shut-off of fluid flow.

SIZE RANGE
Type DZ FIRE SAFE Ball Valves

Threaded End: ¼" through 2"
Flanged: 150# series ½" through 12"
300# series ½" through 12" short pattern
*300# series ½" through 8" standard pattern
*10" and 12" on application
*600# series on application

TEMPERATURES AND PRESSURES

From — 300°F to 450°F
Differentials dependent on seat material and selection. Consult factory for specific applications.



*Where flamability in off-site piping is not a factor the standard range of threaded and flanged Jamesbury "Double-Seal" Ball Valves is available.

**On-site — within battery limits
Off-site — outside battery limits

Technical literature on request

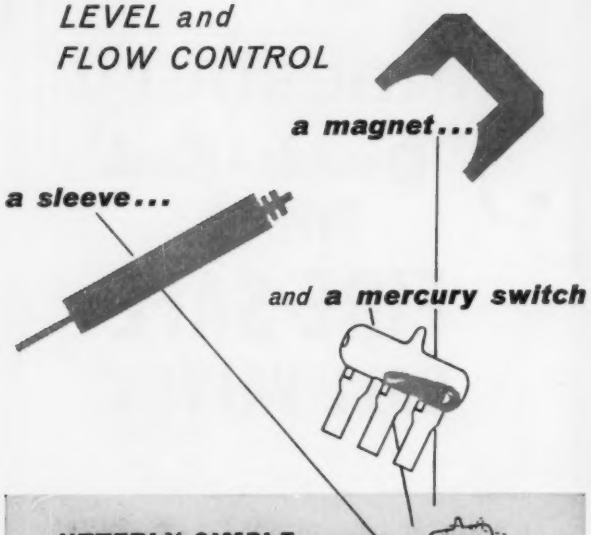
74-1

JAMESBURY CORP.
90 New Street
Worcester, Mass.
Distributors in Principal Cities

For more data on advertised products, use cards, last page.

truly unfailing

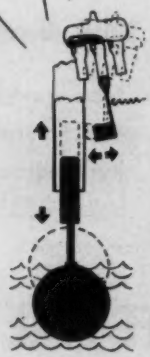
LIQUID
LEVEL and
FLOW CONTROL



UTTERLY SIMPLE

3 unfailing elements safeguard critical liquid level or flow

A **sleeve**, raised and lowered within a nonmagnetic tube as liquid level or flow rates change, attracts or releases a permanent magnet attached to a **mercury switch** outside the tube. That's all there is to it.



MAGNETROL

These three simple elements—the heart of Magnetrol—outmode all bellows, packing glands, and electrodes. Unfailing actuation, as dependable as the pull of a magnet, eliminates all wearing parts and maintenance; nothing to go wrong.

Magnetrols operate indefinitely to protect the critical level or flow of almost **any** liquid, at virtually **any** temperature or pressure. They are so simple that a change in material is usually all that is needed to adapt standard units to any specific application. "Special" Magnetrols are rare.

Magnetrols are available for controlling liquid level changes from ¼" to 150' and more with single or multi-stage switching; flow switches to signal start, stop or insufficient flow within fractions of gpm rates.

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MAGNETROL, Inc., 5312 Belmont Road, Downers Grove, Ill. 16

Please send me catalog data and full information on Magnetrol

☐ Liquid Level Controls ☐ Flow Controls

Name_____

Quiet

that noisy EXHAUST

AIR-GAS-STEAM

PULSCO BLOWDOWN MUTE*

Eliminate ear splitting fatiguing plant noise from exhaust vents with patented PULSCO Blowdown Mutes. Capacity: From 1,500 to 500,000 cfm air and gas. 3,000 to 1,000,000 lb/hr steam. Temperatures to 1,200° F. Overall sound pressure level reduced to 80 - 86 decibels at 100 ft. Excellent silencing plus separating and collecting condensate. Drain provided.

PULSCO MULTIPLE TUBE BLOWDOWN MUTE WITH REPLACEABLE TUBE BUNDLE

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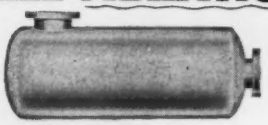
KILL VIBRATION with PULSCO



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STAINLESS & CARBON STEEL TANKS

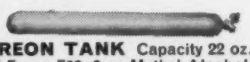
(GOVERNMENT SURPLUS BARGAINS)

Steel tanks for the handling, storage and transportation of gases, beverages, fuels, hydraulic fluids and other liquids. Stainless steel tanks for corrosive acids and gases.

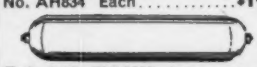
J-1 PRESSURE TANK Stainless steel, surplus aircraft oxygen tank. 48" long, 24" dia. Rated for 400 P.S.I. working pressure, 18,000 cu. in. vol., 77.9 gal. capacity. ¼" pipe thread fitting at each end. New condition. Shipping weight 247 lbs. F.O.B. Chicago.
No. AH832 ..... $99.50

G-1 TANK Stainless steel. Capacity 2100 cu. in. (9 gals.) 450 P.S.I. ¼" pipe thread port at each end. 24" long, 12" dia. Shipping weight 19 lbs. F.O.B. Chicago. (Two for $27.00.)
No. AH63 Each $14.95

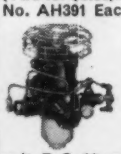
NON-SHATTERABLE CO_2 CYLINDER This type of pressure bottle was used by the Armed Forces for inflating life rafts. 18¼" long, 3¾" dia. Has ½" pipe thread opening at one end. Capacity 2.98 lbs. of CO_2—at 1800 P.S.I. Shipping weight 10 lbs. F.O.B. Chicago.
No. AH303 ..... $2.50



FREON TANK Capacity 22 oz. of Freon F22, 6 cc Methyl Alcohol. 18¼" long, 2" dia. ¾" pipe thread opening at one end. Equipped with brass valve. Shipping weight 3 lbs. F.O.B. Chicago. (Six for $8.00).
No. AH834 Each $1.50



D-2 AIR TANK Carbon steel. Capacity 500 cu. in. (approx. 2 gals.) 450 P.S.I. ¼" pipe thread port at each end. 24" long, 6" dia. Postpaid. (Two for $8.50).
No. AH391 Each $4.95



CORNELIUS HIGH PRESSURE (1500-2000 P.S.I.) AIR COMPRESSOR Three cylinder, 3-stage compressor, complete with 27 volt, D.C. 20 amp. motor, with fan. Rated 1500 P.S.I. continuous duty, 2000 P.S.I. intermittent. Pressure switch in base. As released by Air Force, in used, serviceable condition. Covered by our 30 day GUARANTEE. 11½" long, 7" high, 9" wide. Shipping weight 12 lbs. F.O.B. Chicago. Limited quantity.
No. AH549 ..... $35.00

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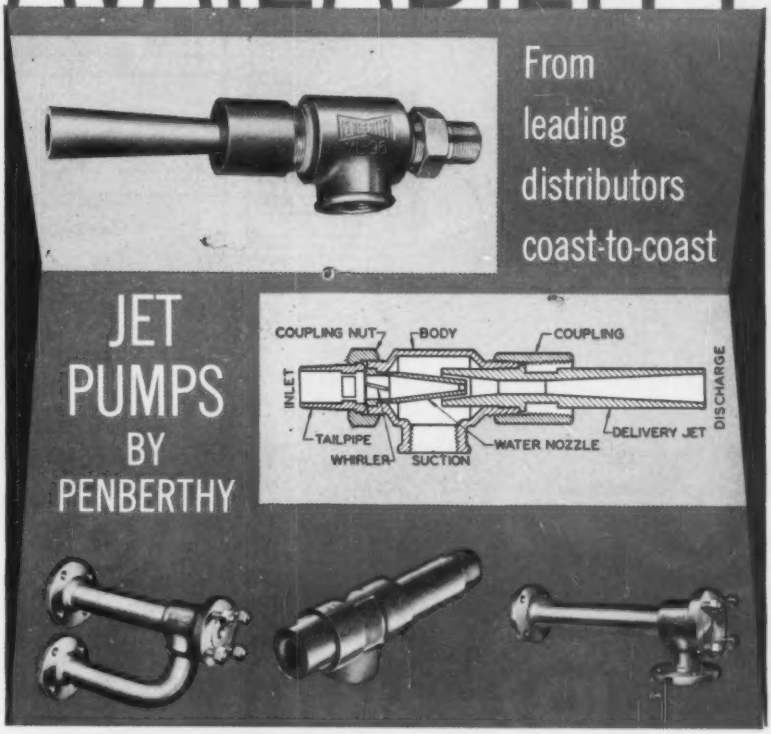
Hawkeye **PRODUCTS CORP.**
212 Dey Building
Iowa City, Iowa

AVAILABILITY



When you want something . . . like a jet pump, for example . . . you *want* it. Not day after tomorrow, or next week, but *now!* Right? And that's just one more advantage of Jet Pumps by Penberthy. Availability . . . *now*.

Penberthy, to begin with, has a broader line with more models and sizes to offer . . . hydraulic, air or steam operated . . . in bronze, iron, stainless steel, monel, plastic and other materials. Penberthy, in addition, offers "standards" on many designs that would be labeled "special" by other manufacturers.

Add to the above, Penberthy's nationwide network of representatives and stocking distributors. They're located in all the major metropolitan areas so, chances are, there's a Penberthy man near you. Be happy to supply his name and address . . . write or call the Penberthy sales office at the address below . . .

PENBERTHY MANUFACTURING COMPANY
Division of Buffalo-Eclipse Corporation
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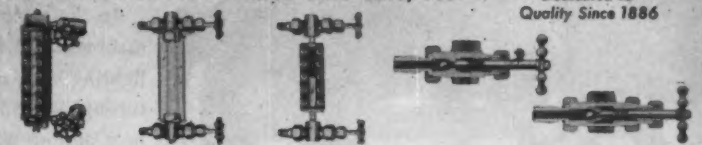
Dedicated to Quality Since 1886

PENBERTHY FOR LIQUID LEVEL GAGE SETS, TOO



WRITE OR CALL PENBERTHY TODAY FOR COMPLETE INFORMATION

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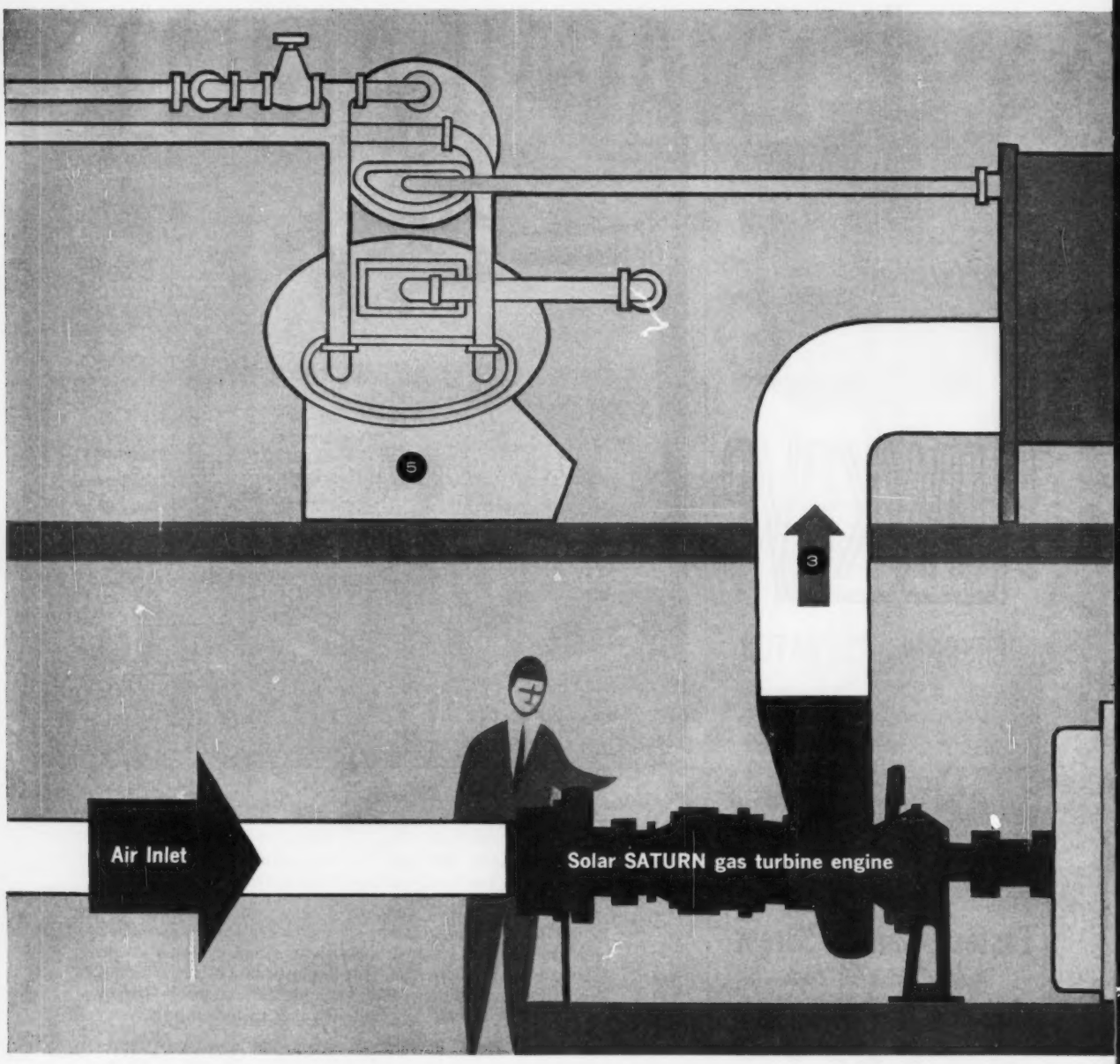
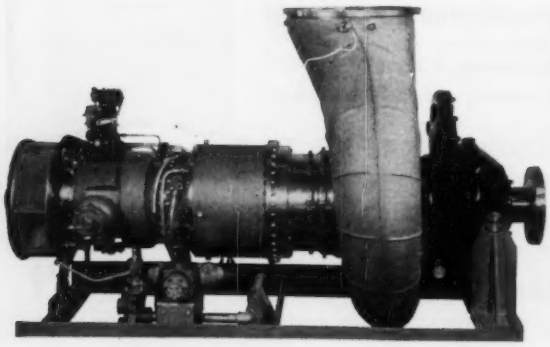


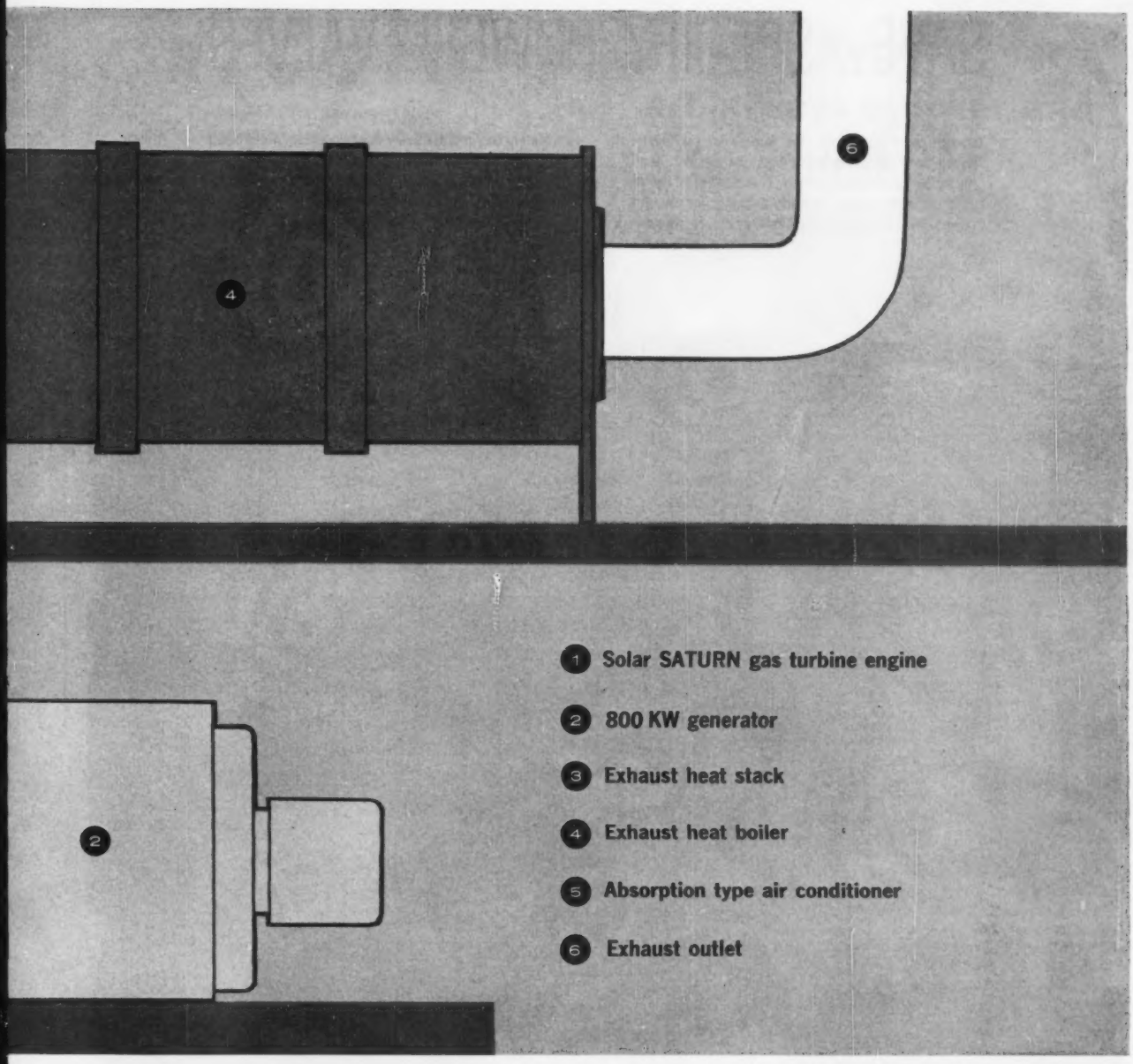
Solar gas turbine exhaust heat



This unique system of exhaust energy utilization illustrates one of the many advantages of Solar gas turbines. In addition to the turbine's main shaft power, exhaust gases go to work to multiply the thermal efficiency of the installation up to three times that of the prime mover alone.

In the typical system illustrated above, Solar *Saturn* gas turbines turn 800 kw generators, providing electricity for lighting and machinery. Turbine exhaust heat is passed through a boiler to provide steam for process or building heat and absorption air conditioning. This installation with three *Saturn* engines produces 2400 kw of electrical energy

For more data on advertised products, use cards, last page.



multiplies thermal efficiency

and 16,150 lbs of steam per hour. The complete package fits in a 60 ft by 40 ft space. The turbines will run on gasoline, kerosene, diesel fuel and natural or manufactured gas.

Exhaust heat utilization systems are easily adaptable to any job where electric power generation is needed, such as manufacturing and processing plants.

Solar gas turbines with their light weight, compactness, lack of vibration, long life and instant start capabilities are ideally suited for such jobs as electrical power generation, pumping, field and pipeline compression, oil well servicing, vehicle or marine propulsion.

Solar's family of gas turbines, from 50 to 1100 hp, are designed specifically for industrial use. Their design and manufacture are the result of over 15 years of experience. For further information, write to Dept. J-120, Solar Aircraft Company, San Diego 12, California.

SOLAR

A subsidiary of International Harvester Company

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You can count on Powell—the world's largest family of valves. Powell valves are stocked across the nation, specifically for the oil industry's needs. This means fast delivery, less down time. In short, important savings for you.
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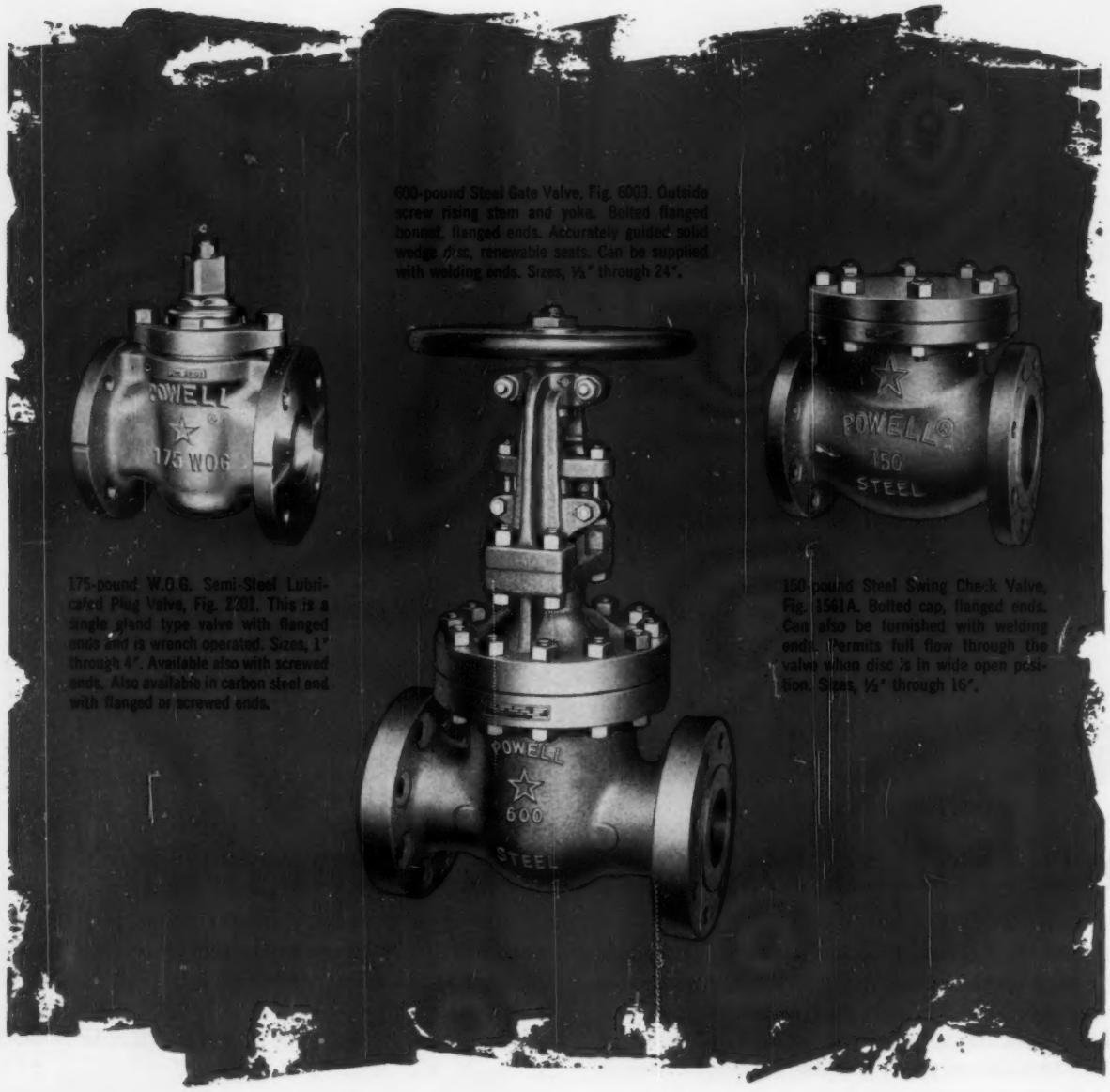


175-pound W.O.G. Semi-Steel Lubricated Plug Valve, Fig. 2201. This is a single stand type valve with flanged ends and is wrench operated. Sizes, 1" through 4". Available also with screwed ends. Also available in carbon steel and with flanged or screwed ends.

600-pound Steel Gate Valve, Fig. 6003. Outside screw rising stem and yoke. Bolted flanged bonnet, flanged ends. Accurately guided solid wedge disc, renewable seats. Can be supplied with welding ends. Sizes, ½" through 24".

150-pound Steel Swing Check Valve, Fig. 1561A. Bolted cap, flanged ends. Can also be furnished with welding ends. Permits full flow through the valve when disc is in wide open position. Sizes, ½" through 16".

115th year of manufacturing industrial valves for the free world

POWELL PETROLEUM VALVES

THE WM. POWELL COMPANY CINCINNATI 22, OHIO

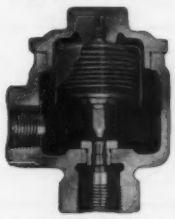
RIGGIO

Thermostatic Steam Traps

For Maximum Efficiency Choose From This Line of Riggio Thermostatic Steam Traps

For pressures from Vacuum to 200 lbs. Bronze Construction ½", ¾", 1"

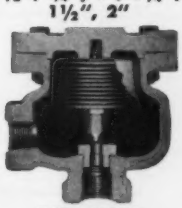
For pressures from Vacuum to 250 lbs. Semi-steel Construction ½", ¾", 1", 1¼", 1½", 2"



TYPE A-200 Freeze-Proof

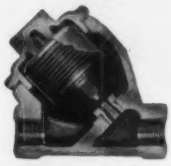
Simple

Rugged



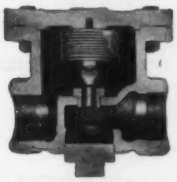
TYPE C-250 Freeze-Proof

Versatile



TYPE Y-200

Tight Shut-off



TYPE B-250

For additional information contact

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SQUARE SPRAY
A NEW DESIGN IN FullJet SPRAY NOZZLES
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SMITH PLIDCO SPLIT-SLEEVE

Drastically reduces downtime losses
Permits welding while pumping

Nothing is quicker and simpler than repairing pipeline leaks with Smith Plidco Split-Sleeve. Assemble halves around pipe. Move assembly over leak and tighten side bolts.

Nothing could be safer. Exclusive steel girderings* prevent leaking oil or gas displacing gaskets. Weld if desired.

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*Patents pending

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Wilson has hundreds more to meet every tube maintenance need. Send for comprehensive catalog 77-88.

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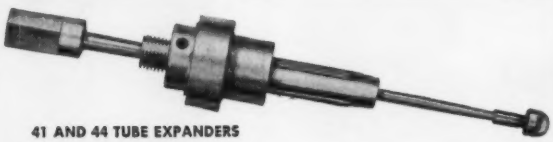
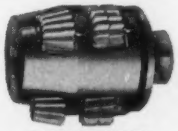
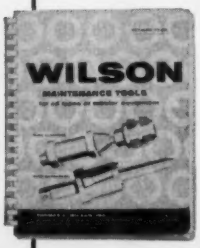
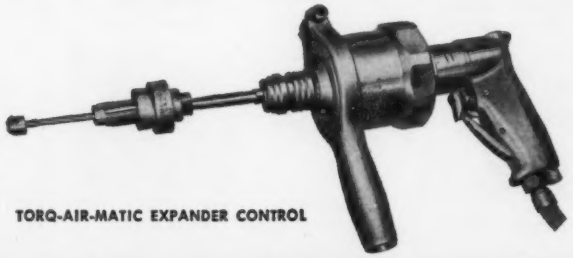

41 AND 44 TUBE EXPANDERS


R CUTTER HEADS




TORQ-AIR-MATIC EXPANDER CONTROL

TW-814

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- **9 interchangeable, direct-reading scales**

Pyrotest is the only portable potentiometer that can check any thermocouple-actuated indicator, controller, or recorder. It comes with 6 thermocouple scales and 3 MV scales—as easy to change as phonograph records. Scale length of over 4 feet, with high resolution to match. Pyrotest is so accurate, it's used as a standard in the lab . . . so versatile and rugged, it's used as an all-purpose tool everywhere in the plant. Only $315.00, fob Indianapolis. Write for free Bulletin 9-B.

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Get top efficiency in industrial process heating

"HI-TURBIANT" HEATERS

Direct-fired process streams (and heating transfer fluids) get hot efficiently — **fast** and **economically** — when a Western Precipitation "Hi-Turbiant" Heater does the job.

A unique and exclusive reradiating baffle is the secret. It assures optimum heat absorption . . . and permits a greater height-to-diameter ratio that keeps friction losses low — pumping efficiency high — and saves floor space. Full range of sizes — 250,000 to 40-million BTU/hr.

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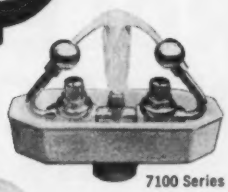
WESTERN PRECIPITATION
DIVISION OF JOY MANUFACTURING COMPANY

SAFETY by HAWS



HAWS SAFETY FOUNTAINS

Wash harmful fuels and chemicals from eyes and facial areas, instantly! Prevent discomfort and serious injury. Units may be wall or pedestal mounted; with hand or foot operated quick-opening valves.

7900 Series—Maximum coverage eye/face-wash. 6 spray outlets in extra large stainless steel bowl set up soft, drenching mist for positive first aid. Large hand valve.

7100 Series—Eye-wash sends pressure-controlled streams from chrome plated brass heads. Acid-resisting enameled iron bowl.

7700 Series—Eye/face-wash simultaneously sprays water from perforated copper ring and fountain heads. Stainless steel bowl.

HAWS SAFETY SHOWERS

Instantly flood the body with torrents of rushing water to wash away injurious contaminants. Your choice of single head or multiple nozzle showers; available with hand or foot valves.

Model 8590—Multiple Nozzle Shower instantly drenches victim from all angles. Large hand valve.

WRITE FOR HAWS DETAILED SAFETY CATALOG TODAY!

HAWS SAFETY EQUIPMENT

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THE HAPPY COMPANY • Drawer 770 • Tulsa 1, Oklahoma

HAPPY

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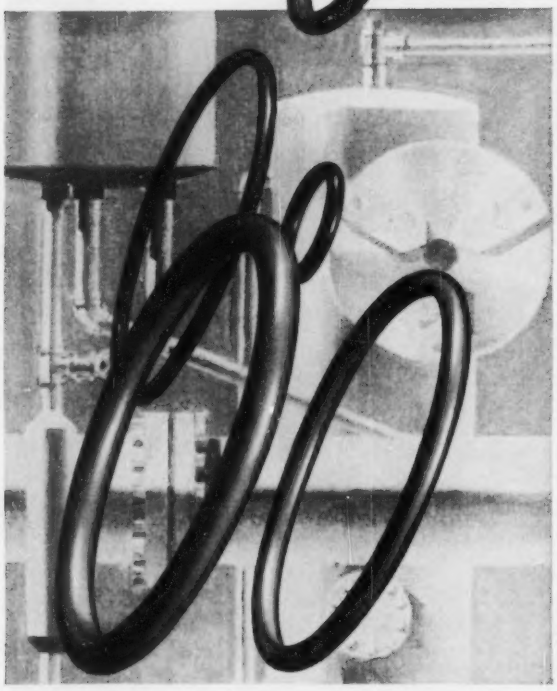
NOW... *for the first time, Stillman aircraft quality and know-how are available in* **"O" INDUSTRIAL RINGS**



Through Stillman Technology and volume production, Stillman high-quality O-Rings are available at extremely low cost. The same quality and reliability that are engineered into O-Rings for the aircraft and missile industries are also featured in the new Stillman Industrial O-Rings. These all-purpose seals are designed for use in all phases of industrial sealing, and are uniformly high in important features of chemical resistance, low swell, long life, and sealing dependability. Stillman O-Rings are stocked in a complete range of sizes for rapid delivery.

Write for the all-new Stillman Industrial O-Ring brochure, free on request.

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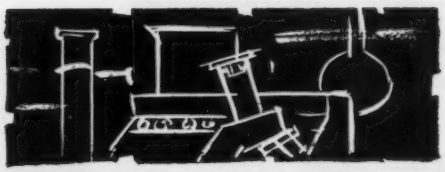

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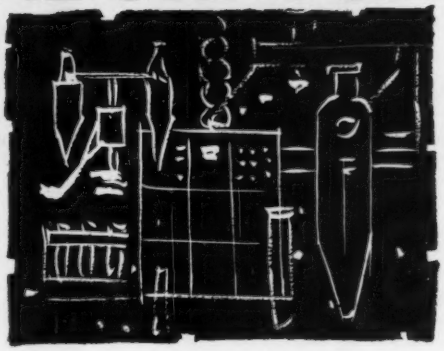

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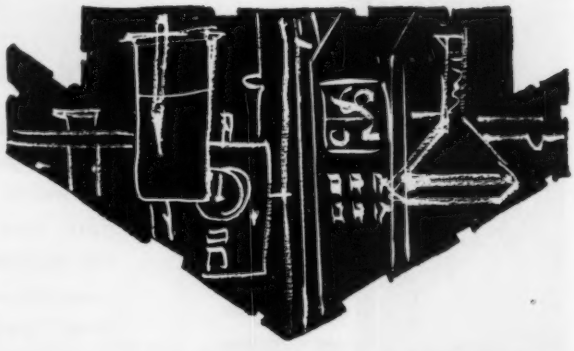

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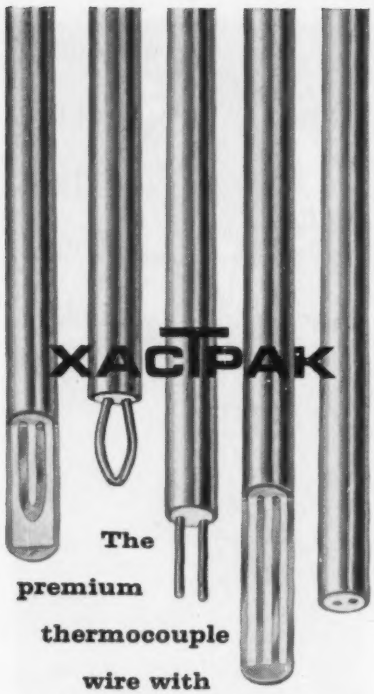

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corrosion control at lowest cost per day*

There are several ways of looking at the cost of corrosion control in cooling water systems. But the only one that means anything from a dollars and cents standpoint is . . . getting *good* control at the *lowest cost per day*. Here are some figures that underline this concept. They are the result of a series of plant trials, each conducted over a 30-day period. Test strips were located at the same points under identical flow and temperature conditions.

Inhibitor	mg/dm²/day	mils/year	cost/day
***HAGATREAT 168**	**7.2**	**1.31**	**$32**
Product A	39.4	7.2	35-40
Product B	26.9	4.95	35-40
Product C	18.19	2.93	32
Product D	34.0	6.2	25
Product E	6.9	1.3	100

Hagatreat is a recent Hagan development that not only provides optimum corrosion control at a very low cost/day, but also simplifies the treatment of cooling water systems. It is effective in protecting iron, steel and copper against corrosion damage with no tendency towards pitting. It stops sludge and scale, and it is easy to handle and feed.

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HAGAN DIVISIONS: CALGON CO. • HALL LABORATORIES • BRUNER CORP.

For more data on advertised products, use cards, last page.

FACTS FOR REFINERS

psd

Instrumentation For Automation

FLASH POINT CONTROL ADDS $45,625 TO ANNUAL PROFITS

American Oil Company told the API Division of Refining at its Mid-year Meeting, that *continuous* flash point testing adds $45,625 to the annual profit of a refiner producing 10,000 B/D of distillate fuels. No. 1 fuel oil can accommodate more heavy naphtha and total production can be increased about 5% by bringing the flash point 5°F. closer to specifications*.

Controlling flash point quality to the optimum level requires continuous monitoring, in contrast to normal practice of submitting only 1 or 2 stream samples once each shift to the laboratory. The CONTINUOUS FLASH POINT RECORDER, developed by Standard Oil Company (Indiana) and licensed exclusively to PRECISION SCIENTIFIC DEVELOPMENT, automatically determines flash every 5 minutes. Results correlate with ASTM Tag Closed test (D56) within 2°, and can be read immediately, enabling operators to pin-point the most effective process adjustments to virtually eliminate off-test production.

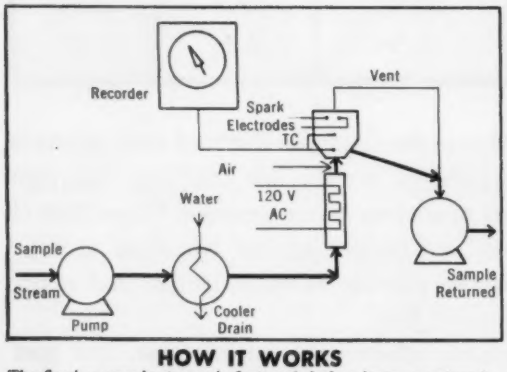
tion. Flash point control also helps reduce other refinery costs, for example, if reprocessing of off-test material is reduced by 1% of total production, savings can amount to $20 per day . . . $7300 per year.

Typical Benefits of Flash-Point Control of No. 1 Fuel Oil

	B/D
Nominal Production	10,000
Added production by 5°F. lower flash point	500
	Dollars
Differential value of added stock, per bbl.	0.25
Value of 5°F. lower flash point, per day	$125.00

Other CONTINUOUS FLASH POINT RECORDER advantages are savings in time and protection against hidden errors and contamination. Process decisions can be made promptly and blending operations speeded by virtue of the continuous record and elimination of delays. Samples are taken directly from a process line, excluding sampling errors. The recorder eliminates oral reporting of test results, avoiding transcription errors. When used to monitor bulk deliveries of products to pipe line or tankers, it safeguards against leaky valves, poor mixing and contamination.

Refiners should study how the CONTINUOUS FLASH POINT RECORDER can add to profits. Request Bulletin No. 702. Let us help solve your special problems.



HOW IT WORKS

The flowing sample stream is first cooled, then its temperature is slowly raised; air is injected. Sample temperature is recorded electronically prior to exposure to high voltage sparks every other second. Following flash, recording pen automatically drops; cycle ends; 2-minute cooling begins, cycle recommences.

Continuous flash point control also gives more distillate production, to meet seasonally heavy demands, without increasing crude runs and processing costs. About 2000 B/D more crude would be required to provide 500 B/D more distillates. Increasing crude runs increases costs and aggravates the problem of maintaining balanced produc-

*PROCESS MONITORS SAVE MONEY AND IMPROVE EFFICIENCY
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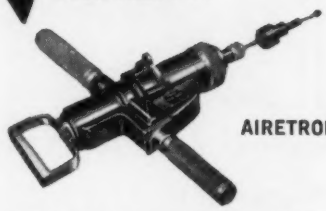

Typical of the speed with which tube maintenance and fabrication can be accomplished is the performance of the Airetrol automatic expansion control. Easy to operate . . . one man can roll 12 tubes a minute to .001" accuracy. Fast micrometer setting, convenient roll throttle, quick change chuck and rugged air motor combine to step up tube maintenance with accuracy.

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✓AT LOWER COST...

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Airetool also makes a full range of brush heads and other type cleaners for straight or curved tubes and, in addition, a complete line of production tools and grinders. Write for a free demonstration in your plant.

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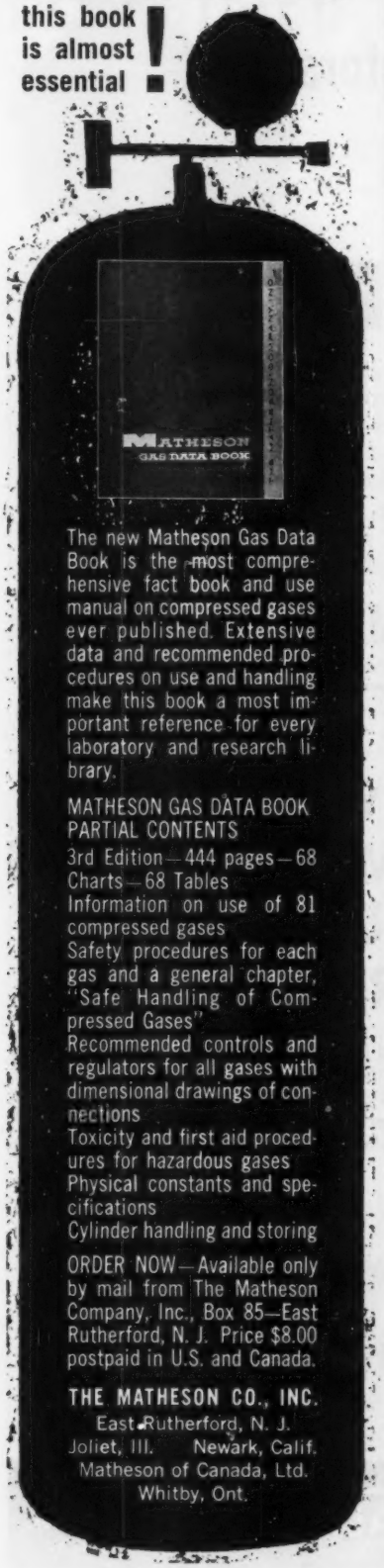

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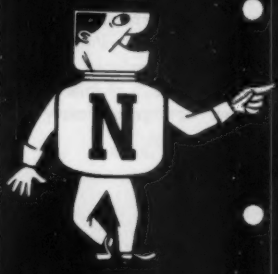

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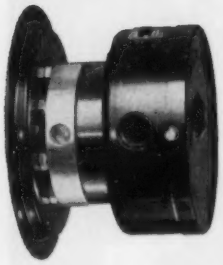

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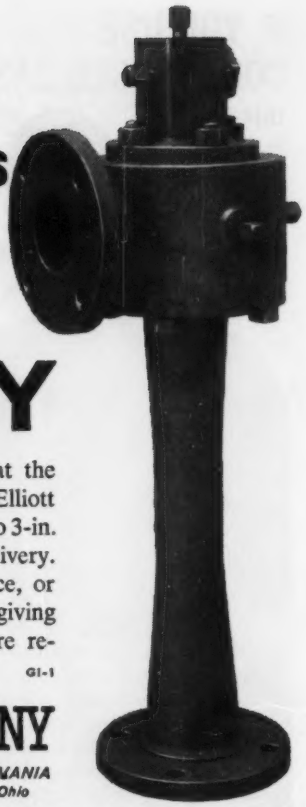

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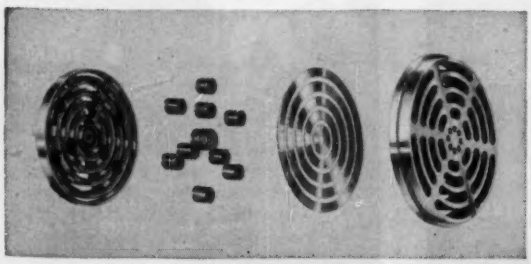

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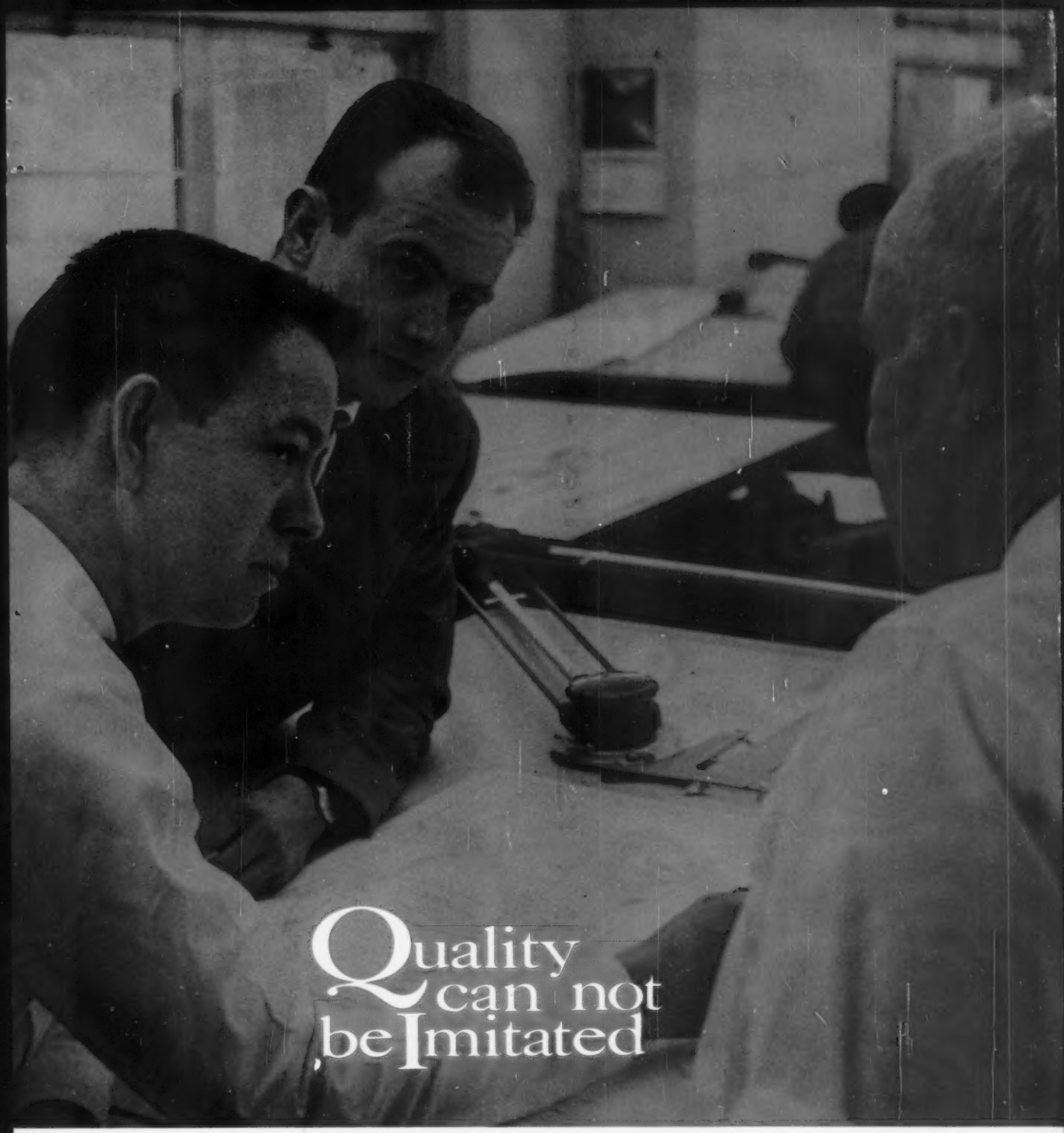

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